APPLIED PSYCHOLOGY

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TO OUR TEACHERS

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PREFACE

Books in the field of applied psychology have tended in the past to belong in one or several of three categories, which may be described in some such way as the following: (1) Technical monographs, such as are intelligible only to the advanced student or the professional psychologist; (2) Volumes covering in an intensive way some particular and limited field of practice, such as education, advertising, mental examination; (3) General and more or less prophetic popular essays, pointing out suggestive fields of interest. There exists no book which well serves as a general text of applied psychology, presenting its principal aims, types, methods, its various fields of endeavor, and its outstanding results and accomplishments. Students of applied psychology must at present be referred to a very scattered series of special articles, monographs or books, of varying value, and by no means generally, easily or equally accessible. The general reader, working without expert guidance, can hardly do more than dip in a random way into magazine stories, subscription books, and an occasional serious exposition of the more restricted type. The general text books of psychology do not have the practical point of view for which he is in search.

Applied psychology is clearly on the way toward a dignified and prosperous existence. The present year has seen

established the first professorship of applied psychology, the first American journal of applied psychology, and university courses and lectureships in applied psychology are rapidly multiplying. Psychology has been recognized as a vocation under the civil service regulations, and applied psychologists are finding themselves called to work in factories, schools, courts, hospitals, agencies, banks, employment departments, and various branches of municipal and civic enterprise. With this record of substantial achievement in applied psychology, it seems only appropriate that there should be also available a general text book devoted to the subject. The authors of the present book have both been engaged for several years in teaching, research and consultation in this field, and have long felt, in their own work, the need for an exposition of the subject, which should be comprehensive, suggestive and interesting without sacrifice of definiteness, accuracy and balance. This need has prompted them to prepare the present book, which it is hoped may be useful at the same time to the student, the teacher and the general reader.

In the earlier part of the text will be found a systematic statement of various aspects, principles and results of modern dynamic psychology which bear in a specially practical way on the personality and competence of the individual, regardless of his or her particular occupational activity. Emphasis is given to problems of original nature and instinctive equipment, the inheritance of mental traits and capacities, individual differences, the conditions and methods of effective work, learning and rest; the psychological influences of such biological factors as age, growth,

sex and race; of such physiological factors as fatigue, drugs, periodicity, posture, sleep; and of such environmental factors as illumination, ventilation, weather, humidity, temperature, time of day, distractions, solitude.

In the latter portion of the text the attitude, content and technique of psychology are considered in their particular relevance to the various types and fields of occupational activity. Attitude, content and technique, yielding three distinguishable forms of application, are illustrated by concrete achievements in those fields in which the relations between science and practice have been most explicitly formulated. These fields include the various departments and activities conveniently classified under the more general headings of Management (employment, supervision, organization, training); Industry (economy of effort, routing, time and motion study); Business (manufacturing, advertising, salesmanship); Law (testimony, evidence, responsibility, prevention and correction); Social Work (misery, delinquency, defectiveness, mental abnormality, social psychology); Medicine (examination and research, pharmaco-psychology, psychotherapy, the psychological clinic, the medical curriculum); Education (school subjects and operations, methods of teaching, individual differences, educational diagnosis, the learning process, educational measurement). A final chapter discusses the various institutional adjustments necessitated by the development of applied psychology, the current and probable future tendencies, and their relative desirability.

In so new and rapidly growing a field as that of applied psychology the teacher and professional student will for a

long time find it useful to supplement even the most encyclopedic text book with concrete results from current investigations and achievements. The present book will have accomplished its aim if it assists in systematizing a field hitherto vague and unorganized, and helps to demonstrate that applied psychology is a dignified, productive and vigorous activity, as well as a fervent hope and a confident prophecy.

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Columbia University,
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CHAPTER I

EFFICIENCY AND APPLIED PSYCHOLOGY

Everyone is familiar with the great increase in the popularity of psychology within recent years. The number of books on psychological topics, the number of so-called psychological plays, of references to psychology in the newspapers and magazines, of efficiency bureaus and similar enterprises in the business world, all indicate a remarkable change in the status of psychology.

Modern Tendencies in Psychology.—What is the cause of this great and sudden popularity? One might surmise that it is due to the fondness of the American people for fads, and that in a few years nothing will be heard of all of these applications of psychology to practical life. But there is another reason which seems far more plausible than this. It is the change which has taken place in the attitude of psychologists themselves toward their problems in the last twenty years. If we go back to the time of Aristotle, we find that psychology was of a speculative nature, and that its subject matter was the

soul. Each philosopher had his own philosophy and arranged his psychology to suit that. Many centuries later there were attempts at an accurate description of the mind; and the mind consisted of consciousness and nothing more. Consequently, there was great difference of opinion as to what the mind was really like. Each man alone could see and examine his own consciousness and no one could dispute what he found. Thus there were possible as many different views of the mind as there were individuals studying it. Many of our psychological problems even today are in a state of confusion for the reason that examination of consciousness offers the only source of information at present available. For instance, some psychologists insist that there are no such things as mental images, because they themselves do not find them in their consciousness. Others assert that there are images but that they are of no use, that they are simply accompaniments of the necessary processes, or are by-products of these necessary activities. Others contend that the mental images are absolutely essential to thought and give them a very high place in the mental life. These differences of opinion are probably inevitable so long as the investigations are limited to the study of consciousness.

Such a state of affairs would naturally be unsatisfactory to those who hoped to make psychology a science. There could be no reduction of the findings to laws, so long as these findings differed in the case

of each individual, and each was a law unto himself. It was necessary to find another source of information about the mind, which would reveal uniformities among different minds, and permit the formulation of a general human psychology. This source of information was found in the behavior of the individual, which might be taken as a sign of what was going on within the mind. When an individual displayed the same outward signs, made the same bodily movements as oneself in an identical situation, he was assumed to be having the same mental experiences. Among the most helpful signs of mental activities in human beings are language signs. By this use of analogy the sphere of psychology was extended to include not only all normal human beings, but also the animal kingdom and that of the insane and undeveloped mind, because each of these classes has outward behavior which corresponds in a way to our own and hence can be interpreted as significant of mental activity. But it is well to keep in mind that these objective forms of behavior were first used as aids to the understanding of the inner life and the formulation of the laws of the mind.

The outward signs of mental life, or the behavior of the individual, have gradually come to attract more and more interest, so that at present, in the opinion of some psychologists, they are the most important aspects of psychology. In this way the tables have been turned and consciousness has become an

aid to the understanding of behavior, instead of the reverse. In fact, there is a more extreme stage than this, among those who call themselves behaviorists. These men ignore consciousness altogether, and maintain that no help can be derived therefrom. Psychology then becomes the study of behavior, the study of the situations in which persons find themselves, and the responses which they make to these situations. It is evident that this kind of study can be made as well on the lowest forms of animal life as on human beings. Indeed, it can be more easily studied in the lowest organisms, where the situations and the responses are most simple, and in this realm the behavior psychologist has done the greater part of his work.

The reason for the great change of emphasis from consciousness to behavior is not alone the difficulty in building up a system of theoretical psychology, but the change must be due in part to demands of practical life. So far as the latter are concerned, it is the behavior of men that is important; it is human action and not human consciousness with which one has to deal. Of course, behavior is here used in a broad sense, and includes not only the gross bodily movements but also the class of bodily responses that we call language. A man's whole life consists in a process of adjustment to his environment, a series of responses to situations, of forms of behavior. To be a success or failure means to succeed or to fail to adjust oneself to one's en-

vironment. A man who responds to the situations in which he is placed in a *normal* manner, or as other people do, is said to be sane; one who fails to adjust himself in this way is said to be insane or out of his mind.

When analyzed from the practical point of view, all education consists in the development and control of behavior, in training an individual so that he shall react normally when put into certain situations. Special training likewise consists in developing the possibility of reactions to particular situations. The education of a stenographer consists in part in training him to react by certain finger movements when certain characters appear before his eyes, or to make certain marks with a pencil when certain sounds strike his ears. All commercial and business life consists in making reactions to specific situations, and the training is only in preparation for the correct responses when the situations are presented. The whole may be expressed by the statement that every act of an individual, no matter how complicated it may be, is capable of analysis into the situation or appeal and the reaction or response to it.

One might ask why the change in the point of view of psychology was so long delayed,—why the theoretical aspect held sway so long. Münsterberg answered this question by saying that every science must reach a certain stage of maturity before practical applications can be made. Such has been the

case with the older sciences of physics and chemistry. The science of psychology is very young in comparison with these, and doubt has sometimes been expressed as to whether it is yet mature enough to afford safe practical applications.

A psychology constructed from this behavior point of view is called dynamic, or behavior, psychology, and its function may be said to be threefold: (1) To give a knowledge of the general principles of behavior. (2) To find how types of behavior may be acquired. (3) To find how the behavior of an individual in any particular situation may be controlled. To satisfy the first of these demands requires a knowledge of the physiological basis of behavior, and especially of the nervous system which controls behavior; to satisfy the second requires a knowledge of what forms of behavior we inherit from our ancestors, immediate and remote, and how this behavior may be modified; to satisfy the third requires a knowledge of the dependence of behavior upon the factors of attention, perception, memory, association, suggestion, and upon such conditions as health, disease, age, sex, together with the influence of such environmental factors as climate, season, temperature, etc. In short, one's behavior at any time depends upon the integrity of his physiological mechanism, upon his heredity, his education, and upon the present stimulus or the appeal to action.

When one considers that all of these sets of conditions are variable factors in different individuals,

it may appear impossible to predict at any one time just what an individual will do, or to control his actions. A further complication is added in that these factors may vary in relative influence in different situations and with different individuals. Yet in spite of all of these varying factors, numerous experiences of our daily life prove to us that the reactions of a number of individuals can be predicted with a fair amount of certainty. The common coincidences in which two people find themselves thinking about the same thing, or about to make the same remark, indicate the power of the stimulus to create the same response in different persons. It simply means that the three other factors aside from the present stimulus have not been so different that a given stimulus cannot bring forth the predicted response. A so-called association test for the diagnosis of various forms of mental abnormality has been constructed on the principle that normal individuals will react in more or less uniform ways, and that any great deviation from these normal forms of action indicates abnormality. One thousand persons were asked to tell the first word that came into their minds when each of a hundred different simple words was read to them. The records were then compiled, showing how the thousand people agreed in their responses to each word. A few of the stimulus words and the responses that were made to them will illustrate the nature of the results. In the following list the first word is the stimulus word,

the second is the response and the figures following show the number of persons out of a thousand that gave this particular response.

dark	light	427	Bible	book	338
man	woman	394	tobacco	smoke	387
soft	hard	365	blossom	flower	467
black	white	339	sour	sweet	349
river	water	393	eagle	bird	567
window	glass	316	lamp	light	650

Give the stimulus word *flower* and one can be almost certain that the response will be *rose,* or give the word *table* and just as certainly will the response be *chair.* When one man meets another on the street and extends his hand in greeting, he does it with the certainty that the other will do likewise. When one considers the matter he will find that all social and business life has for its foundation the assumption that the behavior of human beings can be controlled and predicted with great certainty.

Definition and Scope of Applied Psychology.—In a general way we might define Applied Psychology as the application of the findings of psychology to the affairs of daily life. Münsterberg has made, in his "Psychotechnik," a distinction between theoretical psychology, applied psychology and psychotechnics. The first is what we know as pure or general psychology. The second consists in the explanation by psychological laws of past events and the facts

of other sciences. For example, the explanation of certain historical movements or historical characters by appeal to psychology, and the application of the laws of psychology to the physics of color would be called applied psychology. Likewise, the application of the laws of mathematics to astronomy or the laws of chemistry to physiology would be applied science. Technics, on the other hand, would be represented by the application of the laws of mathematics to the construction of electrical machines for lighting purposes, or by the application of the laws of chemistry to the making of dye stuffs or medicines. So, Münsterberg would define psychotechnics as the application of psychology to the solution of practical problems.

Such a distinction is a limited one, since every scientific discovery has the possibility of leading to some practical application, so that sooner or later it will determine a course of events in the future and for practical life. The scientific construction of medicines demands that the science of chemistry shall first have been applied to physiological processes. When this has been done, in a given concrete situation, examination will show what is lacking in the human organism, or what mechanism is functioning improperly, and medicines may be administered accordingly. Likewise, the proper blending of color dyes in the dyeing and printing of cloth and, in the construction of esthetic color patterns requires that the psychological laws of color

contrast shall first have been applied to the physics of light mixture and the chemistry of dyes. Applied psychology and psychotechnics thus become co-extensive.

In the following pages we shall consider the *field of applied psychology to be every situation in which human behavior is involved and where economy of human energy is of practical importance.* This includes much that would be excluded according to Münsterberg's definition. If one wished to subdivide the field further, it could be done according to the kinds of human behavior or according to the activities in which human beings engage. For instance, we might have the applied psychology of medicine, law, business, education, industry, and a hundred others. Obviously, this would be too cumbersome for treatment in detail and would involve much repetition, since many of the different occupations would include essentially the same forms of behavior and be subject to the same conditions. Our plan will be to study first the behavior of the individual and its economy or efficiency without reference to any particular sorts of occupation. Then we will show how these conditions of efficiency may be observed in the various larger and more important fields of human activity.

History of Applied Psychology.—The history of applied psychology may be divided roughly into epochs or stages. One cannot mark off any definite period when it came into existence. In some crude

form or other it has probably existed as long as men were able to formulate any laws of the mind, whether these laws were correct or not. But one can mark off four periods more or less clearly up to the present.

1.—Long before the time of experimental psychology, persons were accustomed to make use of very vague notions of the workings of the mind in the problems of daily life. The mind was supposed to be subject to the influence of all kinds of outside forces, those of inanimate and animate objects, and consequently, people's behavior was influenced by all kinds of superstitions and myths. Breaking mirrors, spilling salt, putting up an umbrella in the house, getting married on Friday, being a member of a party of thirteen, and the like were unlucky factors in one's experience.

That one cannot work so well when tired as when rested, that the memories of some people are better than of others, that some persons are stupid and others bright, are conclusions that were applied to daily life before they were subjected to scientific test in the laboratory.

2.—After experimental psychology had developed and a mass of standard experiments had been accumulated, there was a tendency to apply these experiments directly to other fields, just as physiological and physical experiments were carried over directly into the psychological laboratory at its beginning. This tendency was perhaps most notice-

able in education and medicine. For instance, education took over directly the experiments in memory, imagination, attention, etc., and tried to use them in solving educational problems. In the attempt to measure any form of complex activity, the procedure consisted in applying a large number of the standard laboratory tests to persons of varying ability in the particular activity. Then those tests that were well done by the experts and poorly done by those known to be poor in the work, were considered good tests of this kind of ability. This procedure is still of much value and is used where it has been impossible to analyze some complex form of activity into its elements. In such cases the best that can be done is to proceed in a random fashion in the hope that some tests will be discovered which will serve as indices of particular ability. It does not necessarily mean that the thing tested is a vital part of the process but for some reason serves as a symptom, in much the same manner that rose spots on the skin serve as a symptom of typhoid fever.

3.—The third stage, the one into which applied psychology is just entering, is that in which the practical problems themselves are studied, and the actual situations form the material of the experiment. For example, in order to test the memory of individuals for advertisements of various kinds, the routine memory experiments with simple material are not used, but the tests are made with advertising material in some actual advertising

medium, such as a magazine or newspaper. In case one wants to know what is the most economical study period for children of a certain age, he goes into the school and tries various lengths of study periods and measures the results of each for its efficiency. In studying the psychology of crime, the psychology of the witness or the criminal, one puts an individual into a situation which has similar mental conditions and tests his reactions. But it is not necessary to put a witness in a courtroom, or put a street car motorman on a street car to test him, although the particular forms of behavior must be duplicated. Where analysis of the behavior into lower terms is not possible or convenient this very procedure of trying the individual out in the task may be resorted to as in the two cases cited above. But the case of telephone operators will illustrate the other procedure. An attempt was made to pick out good operators by putting them at a dummy keyboard and noting the efficiency of their work. It was found that this was a much less valuable method than to analyze the duties of an operator into their elements and to apply tests to these simpler forms of behavior. Rather simple measures of memory, attention and accuracy of movement served as fairly adequate tests.

4.—To this third period must be added a fourth including the type of work begun independently of psychology and under the name of efficiency engineering. It consists mainly of the analysis of vari-

ous tasks into their essential elements and then adapting human behavior to them in such a way as to produce the greatest output with the greatest economy of effort. For instance, a certain series of operations, such as handling machinery, will be photographed with a moving picture machine, or with a stereoscopic camera, and every movement studied. If any movements are found to be superfluous, they must be eliminated. Much of this efficiency research has been accepted as invaluable by the applied psychologist, and in turn the efficiency expert has found that his work has led him into problems which must be referred to the psychologist.

It may seem strange that when such a great amount of attention and money have been expended on perfecting machinery for practical use with a view to economy, that the matter of the human element should have been so long neglected. When thousands of dollars are spent to increase the efficiency of a certain machine, it seems peculiar that the individual handling the machine should not have been studied just as carefully to bring him to his maximum efficiency. For every machine, no matter how automatic it may be, still depends on the human factor for its management. It seems as though this human factor had been left to care for itself on the assumption that common sense ought to tell a person what is the most economical way to do things. On account of this reliance on common sense many of the tests that are made and the changes recom-

mended for the sake of efficiency are at first sight considered trivial. But any series of operations when carefully examined will demonstrate the fact that common sense does not pick out the most economical methods. In fact, from the nature of the case, it seems that this would be impossible. When one begins to learn any performance, common sense will probably select the method which seems easiest at that time. But at a later stage of the training this method may be an actual drawback to further progress. For instance, if one learns to write on the typewriter without instructions, he is almost sure to use the first finger of each hand and to follow all of his movements with his eyes. But it has been demonstrated by experiment that rapid writing requires that it shall be by the touch method and with all of the fingers. Common sense would not start that way, because progress would be too slow and because the difficulties would seem too great.

Much of the neglect of the human factor in efficiency is due to a failure to realize that a few unnecessary movements permitted in such an activity as sewing, would add much to the bodily energy consumed in the course of a day. The following conclusion from an experiment wrongly attributed to one of the writers is as follows:

"... It takes more physical energy to play the 'Evening Star' on a cello than to shovel four tons of coal. He finds further that a pressure average of three and a half pounds per note is exerted and the total for a three-

minute rendition to be nine thousand four hundred and fourteen pounds."

Whether or not this be a correct statement, it serves to emphasize the possibility of great waste of energy from small and unnecessary movements.

A type of work which has been investigated, and which would be considered about as simple as work could possibly be, is that of handling pig-iron, picking up one pig at a time, carrying it a short distance and then dropping it. Yet, by careful analysis of all of the movements made, the output of a man in a day's work was increased from about twelve tons to forty-seven tons. More than this, his working hours were reduced, his pay increased two-thirds and he went home each night much less fatigued than when doing one-fourth of the work. Another type of work, namely, shoveling, has been investigated and has yielded just as startling results. A careful analysis of every movement made in the act of shoveling showed that it was inefficient to use the same type of shovel for all kinds of work and that the shoveler could not wisely determine the rate at which he should work. His common sense would not tell him what would be the state of his efficiency at the close of the day, nor whether he was starting too slowly or too rapidly to get the maximum results for the whole day. Attention to factors such as these is said to have increased the output of each man by a huge per cent. One series of tests

showed that 140 men could do as much as 500 had previously done, and the wages of each of the 140 were raised.

It has probably occurred to the reader that such increase in efficiency must depend somewhat on the choice of the right individuals for the particular task. Not every man could carry 48 tons of pig-iron in a day. It is quite true that applied psychology demands that we have means of selecting individuals according to certain standards,—in other words it demands that we study differences among people as well as likenesses. The early work in psychology consisted in developing the laws of behavior and ignoring the exceptions. Applied psychology demands that just as much attention be paid to the exception as to the average—that the personal differences be taken into account. This emphasis on the differences among people is one of the greatest steps in advance toward a real applied psychology. As soon as the attempt is made to fit a man to his job, or to fit the job to the man, his stupidity, slowness, nervousness, aptitudes, etc., must be known. For instance, if a man wants to become a typesetter, he should be tested to see whether his reactions are rapid enough to make him able to compete with others. He may be an individual whose reactions to stimuli are habitually so slow as to disqualify him for certain occupations. A man who wishes to become an aëroplane driver must be one whose reactions to changes of position are rapid

enough to prevent his machine from turning turtle completely before he can make the movements to right it.

The fundamental fact of applied psychology is that the individual is the unit of action, and all advance in this science must rest upon a knowledge of the laws of individual behavior, and the conditions which affect it. To one who reviews the field of modern business, industry and education, the striking thing is the emphasis that is being placed on the individual rather than the group. It can be seen in education, in the recognition of the fact that the individual should be the real unit rather than the class, although actual practice is limited to an approximation to this ideal; it can be seen in the administration of charity which now consists in the study of individual cases; it can be seen in industry in the use of the piece work system and reward system, which base pay on what the individual can do; the consideration of the individual in the construction of machinery; the arrangement of hours of labor, rest, vacations; the consideration of the individual in the selection and training of employees.

Difficulties and Limitations of Applied Psychology.—One of the great dangers for applied psychology is that too much may be expected of it, and that it may be extended into fields where it is not prepared to go. In fact, its great popularity has led some venturous spirits to carry it quite beyond

the zone of safety. Two difficulties inherent in the subject may be pointed out:

1.—The problems and situations of daily life are extremely complicated and are influenced by a great many factors. Consequently, great care must be taken that no important factors are overlooked in analysis. Correct results demand an analysis, not only of the task into its elements, but wherever possible of the total behavior into its elements. Errors may be due to incompleteness in either of these spheres. One example will suffice to indicate this danger. There is among the results of experimental psychology what is called the curve of forgetting, which shows the rate at which the average mind forgets simple material with the passage of time. It has been found that forgetting goes on very rapidly for a period immediately after the learning, but the rate becomes slower and slower as the time lengthens. This curve of forgetting has been proposed as a basis according to which business houses shall send out their follow-up letters in order to get the maximum effect. Since forgetting is most rapid during the very early stages, a schedule must be arranged by which the letters shall be sent out rather frequently at first and gradually becoming fewer and fewer as time goes on. Whether such reasoning can be carried over from the laboratory experiments on simple material to the complicated situation of the mail order business, might, of course, depend on many other factors of equally practical importance.

2.—Psychology will always be limited by the fact that while it can determine the means to the end, it can have nothing to do with the determination of the end itself. For example, it may be able to tell how to arrange the labor economically for the construction of a bridge, but whether the bridge should be built or not is another question; it may tell how to get information from a person accused of a crime, or from a material witness without his knowing it or even against his will, but whether that is the right thing to do must remain for ethics or sociology to decide; it may be able to tell how to sell an order of goods to a purchaser who does not want the goods, but whether this would be ethical or not psychology need not decide. In short, it may determine means, but the determination of ends and their values is beyond its sphere.

CHAPTER II

INFLUENCE OF HEREDITY UPON ACHIEVEMENT

However one may choose to take sides on the question as to whether heredity or environment is the more important, it must be agreed that the fundamental basis of all human efficiency is to be found in the physical and mental constitution which is given to one as a legacy by his ancestors. We start with an inheritance good or bad and upon this basis our success or failure must be established. Much investigation has been carried on, in recent years, to determine whether certain special aptitudes, such as musical or mathematical ability, are inherited. Although such questions as these are more or less in dispute there are certain fundamental facts which are generally agreed upon. We will take up the problem by beginning with the more general inherited characteristics, following this with the discussion of more and more specific qualities, somewhat as follows:

I. Inheritance common to the human species.
II. Inheritance common to particular races.
III. Inheritance in families.

Underlying the whole question of inheritance is that of the mechanism of inheritance and closely related to this that of the bodily seat of the inherited qualities. The problem of the mechanism of inheritance or the laws of inheritance is of great importance for the elimination of bad and the preservation of good characters, but this problem is too involved to be discussed here. We are interested mainly in the study of the facts of inheritance; to put them together into a theory would be to select that biological theory into which the facts best fit.

So far as the bodily seat of the inherited qualities is concerned it may be said that they are represented by conditions in the central nervous system, the brain, or cerebrum, the cerebellum and the spinal cord. The nervous system is thought of as a system made up of centers and connecting pathways very much like a large telephone system with its central station, its local and private exchanges, and the tremendous number of wires connecting these stations. Certain pathways open to travel mean that certain bodily activities will take place when stimuli affect the senses. The inherited tendencies are conceived as conditions of lowered resistance in certain pathways which make them open to use without any previous exercise. Just as habits are thought of as certain changes produced in the conduction units, or neurones, so the inherited tendencies are represented by relatively simple and fixed paths of conduction predetermined for the individual, and cer-

tain more complex systems of conduction paths which are linked together so as to function in a predetermined way.

I. Inheritance common to the human species.

A.—*Reflexes.*—At birth our bodily mechanism is so constructed that certain simple forms of behavior will occur when certain definite stimuli affect our sense organs. A bright light falling into a new-born baby's eye will cause the pupil of the eye to contract; food placed in the mouth will cause acts of swallowing. These together with the acts of emptying the bowels and bladder and many more activities necessary for the preservation of life are known as reflexes. These are characterized by:

a.—Their automatic nature. As long as the mechanism is intact, a certain movement follows a certain stimulus with a machine-like precision.

b.—Their independence of consciousness. These reflex responses may become known to us in one way or another, but they are not under our control, except in a few rather remarkable cases, which must be considered as abnormalities.

c.—By their similarity in all people.

d.—By their relative fixity. These reflexes cannot ordinarily be changed or varied as a result of experience, other than the breaking down of the physiological mechanism underlying them.

On account of these four characteristics they are of no great interest to the applied psychologist so long as they function normally. When any abnormality develops in these reflexes, it may serve as a symptom of more severe behavior disturbances that may follow. For example, the knee jerk, the pupillary reflex and others serve as signs of the approach of locomotor ataxia, paresis and the like.

B.—*Instincts.*—In addition to the simple reflexes functioning at birth there is a large group of more complex activities included as part of our original equipment, and known as instincts. It is known that they are not learned by the individual because,—

a.—They appear to function more or less adequately the first time the stimulus which excites them is received.

b.—They are common to the human race as a whole, however much the surroundings of the various groups of peoples may differ. And further, a large proportion of these activities are common to the higher animals, as well as man. In addition to these two characteristics, instincts are further characterized by

c.—Their complexity as compared with the reflexes, in that they consist of a chain or series of movements occurring in an orderly sequence.

d.—They are usually accompanied by consciousness, although they do not always depend on consciousness for their control.

e.—They are modifiable in the course of the individual's life experience.

This group of activities or tendencies to activity is of especial importance to the student of behavior and efficiency for three reasons:

1.—The acquisition of all kinds of behavior, however complex and however much learning may be involved, constitutes modification of these original forms of behavior. It is a rule that all learning must proceed from the known to the unknown or that learning consists in the modification of something that the individual can already do. Thus if an organism lack some of the instinctive forms of behavior, its ultimate development will be defective to that extent.

2.—Many of our acts throughout our whole life are guided and controlled by these instinctive tendencies. However much they may be modified by experience and learning, we still retain the direct and unlearned form of response under many circumstances. This is especially true where for any reason the inhibitions placed by society upon our actions are removed or disregarded, as in great emotional disturbances, in anger, sorrow, joy and the like. For instance, many of the atrocities committed by soldiers in war, and by persons in mobs, are attributed to the fact that these unlearned tendencies to action are no longer under control. But we act instinctively in many cases where one would not at first suspect it—the things we attend to, are inter-

ested in, and the things we like and dislike are to a large extent determined by instinct. A knowledge of the nature and the strength of these instinctive tendencies enables one to select stimuli for their arousal and consequently to exercise some control over the behavior of people.

3.—Instincts are subject to the most extreme variation in two directions, that is, certain tendencies may be abnormally strong or abnormally weak. In either case profound modifications of the total behavior result. Failure to recognize the deep-seated cause of many of the variations of human behavior, especially the criminal types of behavior, has led to a wrong conception of how such conditions may be successfully treated.

Two examples from the business world will illustrate the use of a knowledge of the instincts. The advertising man who puts up the largest and most brilliant sign knows that, other things being equal, it will draw attention from its less brilliant neighbors, because we have an inborn tendency to be attracted by large and bright objects. Again, a book agent who tries to sell a dictionary to a mother and emphasizes its necessity for the education of her children will sell where another who neglects this point might not, because of the great strength of the parental instinct.

A complete catalogue of the instinctive tendencies of human beings would be extremely large, hence we will consider only those which have most importance

from our point of view. First let us consider five fundamental characteristics of our original natures as described by Thorndike.

1.—We are born with the possibility of getting sensations of certain definite kinds when certain stimuli affect our sense organs. This simply means that we are born with sense organs and brain structure such that certain stimuli produce specific forms of reaction in consciousness. This fact is so obvious that it is likely to be overlooked, and yet the great change in the mental life caused by the failure of any part of this mechanism to function, as in the case of congenital blindness, shows the importance of this original equipment. Furthermore, we are given a mechanism of a *certain sensitivity* and this sensitivity cannot be increased directly. All that can be done is to make the best use of the mechanism as it is given to us. Individual differences in sensitivity are relatively fixed, and in each case mark the limits of efficiency beyond which the individual cannot go, however great his training.

2.—Another characteristic of our original equipment is that out of all of the stimuli which affect our sense organs, certain ones will come clearly into consciousness while others will be crowded out. This means that we are born with a tendency to pay attention to certain kinds of stimuli in preference to others, or that we naturally attend to some kinds of objects. This natural attention is of great importance, for it forms the foundation of all of the

highest forms of attention. If it be lacking there is no means by which the behavior of the individual may be modified. Moreover, we are born with the possibility of a certain strength of attention, and it is the difference in this native attention strength which is responsible for much of the difference in accomplishment of different individuals. For instance, according to some authorities, that which makes the musician or the artist or the mathematician is, among other causes, the difference in the character and intensity of his original attentiveness rather than the fact that he has inherited some specific ability directly.

3.—Some of the stimuli which cause sensations and make us attend affect us pleasantly and some affect us unpleasantly. There is a feeling of one kind or another which accompanies most of our sensations. Thus a bitter taste is naturally unpleasant, as anyone can discover who tries to feed something bitter to a very young baby. The way in which, during the course of evolution, certain stimuli have come to produce these unpleasant conscious states is interesting to speculate upon but does not alter the facts. What interests us more than the feeling is the behavior that accompanies or follows the feelings. In the presence of unpleasant stimuli we naturally respond so as to get rid of the unpleasant, and the responses continue in varying form until this result is accomplished. This variety of response which follows upon the receipt of unpleasant

stimuli in the effort to get rid of them, and upon the pleasant in seeking to retain them, forms the foundation of all modification of the instinctive tendencies, which we have said constitutes learning. Furthermore, as will be shown later, the strength of one's memory for objects or experiences depends among other things on the type of feelings they arouse, hence the importance of arousing the proper feeling tone in connection with experiences to be attended to or remembered.

4.—We are said to have a natural tendency to be active both mentally and physically. The specific character of our activity may be and usually is determined by various factors in our environment, but the activity itself is an inherited tendency. There is no such thing as laziness, strictly speaking. To refuse to be active is a symptom of defect or disease, lowered bodily tone, improper nourishment or the like. Laziness, however, is not so much inactivity as activity in a wrong or useless direction, as judged by social or ethical standards.

5.—Of all of the stimuli which affect our sense organs, are attended to, and cause a pleasant or unpleasant reaction, some leave a permanent effect, are remembered, and others are forgotten. This fact like sensitiveness, is taken so much for granted that its great importance impresses us only when some abnormality appears. Retentiveness depends upon a fundamental characteristic of the nervous system, its impressibility, which is not subject to

improvement, according to James and others. Thus one's possibilities of memory are fixed by his heredity, although his actual accomplishments within this limit may depend on education and other factors.

In addition to these five fundamental facts of inheritance, there are a number of more specific reactions to specific situations in our environment, and it is to these that the term "instinct" is commonly applied. As stated earlier, we are interested in them because of their great strength and influence upon all of our behavior. For a full discussion of these tendencies the reader is referred to special texts on the subject. However, a few of them will be briefly described.

1.—The instinct of self-preservation is a name given to a group of tendencies to action which protect the individual. In this group would be included the food-taking tendencies, and all sorts of protective movements, such as putting out the hand when falling. The flight reaction accompanied by the mental state of fear is the tendency to protect one's self from dangerous objects. When the flight reaction is inhibited from any cause, the mental state may still be present and in very intense form. Whenever stimuli, which instinctively provoke a fear response, are presented to an individual, one may be sure of a strong reaction on the part of the recipient. To take an example from the business world, any advertisement which works upon the instinctive fear of disease or death will be successful in producing

some kind of a reaction, e. g., the recommendation of overshoes to prevent grippe, or the immediate use of dioxogen to prevent blood poisoning and death.

2.—*Curiosity.*—The appeal to one's curiosity is a powerful stimulus to action observed in both man and the animals. Sometimes, indeed, it is so powerful as to compete with the instinct of self-preservation. In cases like this an animal will risk its life in order to satisfy its curiosity. Animals are often caught by appealing to this instinctive tendency to examine or investigate. The makers of grab bags and prize packages well know the power of this instinct in children, and many manufacturers seem to assume that it is just as strong in the case of adults. Modified and controlled by experience, this same curiosity forms the driving force of the scientific investigator. The point of importance for us is that it is a factor that must be taken into account in explaining the behavior of human beings, whether children or adults; and, further, that persons differ in the strength of this instinctive tendency to investigate and examine.

3.—*Collecting Instinct.*—The collecting instinct in animals is well illustrated in the case of the wood-rat cited by James:

I found the outside of the nest to be composed entirely of spikes, all laid with symmetry, so as to present the points of the nails outward. In the center of this mass was the nest, composed of finely divided fibers of

hemp-packing. Interlaced with the spikes were the following: about two dozen knives, forks and spoons; all the butcher's knives, three in number; a large carving knife, fork and steel; several large plugs of tobacco . . . an old purse containing some silver, matches and tobacco; nearly all the small tools from the tool closets, with several large augers . . . all of which must have been transported some distance, as they were originally stored in different parts of the house. The outside casing of a silver watch was disposed of in one part of the pile, the glass of the same watch in another, and the works in still another.

The boy's pocket which contains such a variety of objects also bears witness of the force of this collecting tendency. Nearly everyone has at some time or other had a hobby for collecting some quite useless article, coins, buttons, stamps, tobacco tags and the like. To the force of this instinctive tendency, more than to the actual value of these objects, is due the great popularity of trading stamps, souvenirs, coupons, etc.

Abnormal development of this tendency shows itself in the hoarding of gold by a miser, in the thefts of the kleptomaniac, and the collecting of absurd articles by inmates of institutions for the insane.

4.—*Pugnacity.*—The fighting instinct in human beings, on account of the power of social order, does not commonly show itself in physical combat. But the love of combat may take the milder form of watching a cock fight, dog fight, or a pugilistic contest. Most frequently it shows itself as emula-

tion and rivalry of a more kindly sort, and is a healthy stimulus to do one's best and better than one's neighbor. The slavery of fashion is due in part to this instinct; and the limits to which people will go to outdo each other in following the latest styles, and in owning the latest model of an automobile show the intensity of this instinct. When the rivalry consists in trying to excel one's own past record, it becomes one of the most valuable tools of education and industry.

5.—*Sociability.*—There is a very definite tendency among animals and human beings to gather into groups and to react unpleasantly toward solitude. One of the most terrible punishments to which a human being can be subjected is solitary confinement. Many animals become terror stricken when separated from their fellows and give evidence of joy when returned to them. The great popularity of seaside resorts, circuses, football and baseball games, is due in large part to the crowds and the consequent stimulus to this instinctive tendency. Who would enjoy a great football game if he had to stand alone in the cold and watch it? The theater managers, too, know well the influence of a full house upon the popularity of a play. According to MacDougall, those of us who explain our enjoyment of crowds as a purely intellectual interest in people are really misinterpreting an attempt to satisfy our sociability instinct.

An abnormal development of this instinct is

counted among the fears. The fear of being alone, the fear of being in open places, such as street crossings, may be considered as a variation of this instinct. The latter is generally relieved or absent in the presence of other people.

6.—*Imitation.*—Although a tendency to imitate which would enable one to repeat what he sees being done by another and what he had before been unable to do, is denied by many present-day psychologists as a powerful factor in learning new acts, still the term "imitation" is of use in describing certain tendencies in human conduct. The quarrel is as to whether one's learning is in the last analysis reducible to imitation. This question will be dealt with in connection with the problem of learning. The so-called psychology of the crowd which attempts to account for what a crowd will do that one isolated individual will not do, is the psychology of imitation. This, of course, is not a matter of learning to do something new, but merely a determination of which act of a great number of learned ones shall be carried on at a given time. The strength of this tendency is well recognized by the business world, which makes it the basis of many of its appeals to purchasers, and by industry, which uses it as a stimulus to increased activity. To take the last-named case, it is a common thing in industries where efficiency is the aim, to put a good man in the midst of a group of slower individuals on the assumption

that the poorer ones will imitate the better and thus be urged to increased activity.

7.—There is a group of instinctive tendencies called racial, on account of their value to the race or species rather than to the individual. These are very powerful and deep-seated tendencies to action and must be considered in a study of behavior. They are generally characterized by unconsciousness of the end to which they lead. In animals they are the most common and powerful instincts, comprising the nest-building and the egg-laying instincts, the care of the young, the protection of the group at the cost of the individual life, and the procreation of offspring. In man they are curbed and veiled by social laws and customs, but in the form of the maternal instinct and the sex instincts, love and jealousy, they are powerful stimulants to action and of importance in the determination of behavior. The willingness of a soldier to die for the sake of his country, when all the results of training and tradition are subtracted, has, by some authorities, been attributed to one of these racial instincts.

II. Inheritance peculiar to specific races.—Are there characteristics of mind and behavior peculiar to the different races of man, which need to be considered from the point of view of efficiency? We hear much nowadays about hereditary racial differences—that the Germans represent a race with certain characters, the French with others, the English with others, etc., with practically no attempt to sep-

arate the facts of inheritance from the effects of education, customs and general environmental conditions. The actual experimental studies have been made on rather simple functions, such as sensory acuity, motor ability (speed of reaction, speed of tapping, etc.), and simple judgments (form board test, etc.). Although these traits are simple, yet they are characteristics in which peoples are supposed in the popular mind to differ. For instance, certain races are thought to have remarkably keen vision, others are said to be very slow, others very quick in their reactions. The upshot of all of the experimental tests seems to be that the racial differences in fundamental qualities independent of training are slight. There is in every case, even in sensory acuity and speed of reaction, much variability among the members of the same race, so that in the race making the best records there are always some individuals who do as poorly as some of the best individuals in the poorer races. Professor Woodworth in discussing the results of the form board test, which is a fair test of intelligence and little dependent on specific training, and which he tried on a number of different races, says:

> As between whites, Indians, Eskimos, Ainus, Filipinos and Singalese, the average differences were small and much overlapping occurred. As between these groups however, and the Igorot and Negrito from the Philippines and a few reputed Pigmies from the Congo, the average differences were great and the overlapping was small. . . .

If the results could be taken at their face value they would indicate differences of intelligence between races, giving such races as the Pigmy and the Negrito a low station as compared with that of most mankind. The fairness of the test is however not beyond question; it may have been of a more unfamiliar sort to these wild hunting folk than to the more settled groups. This crumb is, at any rate, about all the testing psychologist has yet to offer on the question of racial differences in intelligence.

When one takes the full meaning of this statement, namely, that between the highest and the lowest races there are no differences which have up to this time been positively established, it is scarcely to be expected that differences of any importance would be found among the higher races themselves.

More comparative measurements have been made of the negroes and whites than any other pair of races. Galton believed that, making allowance for difference of environment, the negroes were inferior to Europeans by about one-eighth of the difference between Aristotle and the lowest idiot. The measurements made by Mayo of negroes and whites of the same social standing in the New York City public schools is worth mentioning in this connection. Although the two groups were perhaps not exactly comparable on account of the different social status of the two races, the difference is not very considerable. It has been estimated that the negroes represented a somewhat more rigid selection than the whites. Mayo studied the academic records of

the two groups, and concluded that in academic achievement only three-tenths of the negroes reached a position attained by one-half of the whites. This means that the range from zero up to a grade of 70 would include 50% of the whites and 70% of the blacks. Further, he found the variability of the negroes to be slightly less than that of the whites. This would be the more important finding, if the difference in variability were large enough to be significant. It would mean that among the whites there would be a greater chance for exceptional individuals to appear, both good and bad; that is, one would expect the men who became greatest to be white rather than black.

So far as applied psychology is interested in the question of racial differences, the following statement made by Thorndike will serve as a satisfactory answer:

> From all these facts the student may make his own estimate of the original mental differences of races, and learn the need of more actual measurements of race differences and of intelligence in interpreting them. My own estimate is that greater differences will be found in the case of the so-called "higher" traits, such as the capacity to associate and to analyze, thinking with parts or elements, and originality, than in the case of sensory and sensori-motor traits, but that there will be very great overlapping. . . . Even if the differences were larger than these (such differences as the above statements show) the practical precept for education would remain unchanged. It is, of course, that selection by race of original natures

to be educated is nowhere nearly as effective as selection of the superior individuals regardless of race. There is much overlapping, and the differences in original nature within the same race are, except in extreme cases, many times as great as the differences between races as a whole.

CHAPTER III

FAMILY INHERITANCE

I. Physical Inheritance.—In addition to the original characteristics common to the human species and to the race to which one belongs, every individual possesses certain traits by virtue of having a certain immediate ancestry. The influence of ancestry upon a number of physical characteristics such as eye and hair color, height, etc., has been worked out. Mental resemblances are not so definitely determined, but those which have been found, supported by the certainty of physical inheritance, lead us to expect that one's immediate ancestry is of considerable importance in determining what his mental qualities shall be.

It should not be expected that, if heredity is a real factor, two persons of the same ancestry should have original natures which are identical in every respect, except as a different environment changed them. This may be easily proved by taking physical characters which cannot be affected by environment, e. g., color of the eyes. The coefficient of correlation of two brothers in eye color is only .52, on the principle that if they were always identical the co-

efficient would be 1.00 and that if there were only a chance relation between them, the correlation would be zero. To make the relation still clearer, if every person who had a brother with blue eyes had blue eyes also, and if every person who had a brother with gray eyes had gray eyes also, and so on with every color, then the coefficient would be 1.00. But if one with blue eyes might have a brother with any eye color, then the correlation would be zero.

Take height as another illustration. Children of parents who are three inches above the average in height, will average only about two inches above the average, i. e., they will not be identical in height with their parents but will tend toward the average of the whole race. Thorndike describes the reason for these variations as follows:

In all thought of inheritance, physical or mental, one should always remember that children spring, not from their parents' bodies and minds, but from the germs of those parents. The qualities of the germs of a man are what we should know in order to prophesy directly the traits of his children. One quality these germs surely possess. They are variable. Discarding syntax and elegance for emphasis, we may say that the germs of a six-foot man include some six-foot germs, some six-foot-one germs, some six-foot-two, some five-foot-eleven, some five-foot-ten, etc. Each human being gives to the future, not himself, but a variable group of germs. This hypothesis of the variability of the germs explains the fact that short parents may have tall sons, gifted parents stupid sons,[1] the same parents unlike sons.

Other well established relations between relatives in regard to physical traits are:

Trait	*Individuals*	*Correlation*
Height	father and son	.30
"	brother and brother	.50
Cephalic index	" " "	.50
Hair color	" " "	.60

These figures show very clearly that one owes his physical characteristics to a certain extent to his immediate ancestry.

Consider next a characteristic that comes a little nearer to being mental, namely deafness. It has been found from statistical studies that out of every four persons who have one brother or sister congenitally deaf, *one* is deaf, while of those persons who have neither brothers nor sisters born deaf, only one out of a thousand is deaf. This means that if one is of the same immediate ancestry as a person congenitally deaf, he is about two hundred and fifty times more likely to be deaf than a person who is of the same ancestry as a hearing person.

II. General and Special Mental Inheritance.—A number of statistical studies have been made which tend to show that general mental and moral traits are inherited. In fact, this is so generally believed that only one recent study need be mentioned as an illustration. Thorndike studied 168 families, each having only two children. In 138 of these families

both children were "accelerated" or bright, or both were retarded or dull. The remainder of the group, 80 families, had only one of the two children bright and the other dull. That is, to put the conclusion into a single statement, there is a very high correlation between brothers and sisters in intelligence.

Francis Galton has made a statistical study of the inheritance of *specific* mental abilities and found that the abilities required for success as a judge, statesman, minister, commander, poet, artist and scientific man, are inherited. But the nature of his data makes him unable to make exact allowance for influences of training and environmental influences. Consequently, his figures might really show general intelligence to be inherited and the form of its expression to be dependent upon environment.

Other investigators, among them F. A. Woods and Havelock Ellis, have made similar statistical studies and conclude that there is inheritance of even such qualities as temper, common sense, and the like, but these reports are also subject to the same complicating influence of environment.

Thorndike experimented upon a large number of pairs of twins with many of the simple mental tests to determine similarity of mental ability, and found the following coefficients of correlation as compared with those for brothers and sisters, and unrelated children, the figures representing the combined results of all of the tests:

Unrelated children	.00 correlation
Brothers and sisters	.40 correlation
Twins	.80 correlation

The influence of inheritance upon a *very specific* mental quality, namely, spelling ability, has been tested experimentally, although here there is some difficulty in separating the influence of heredity from that of environment. Earle studied the spelling ability of 180 pairs of brothers and sisters, who had uniform school training, and found a correlation between brother and sister of .50. This means that if one child deviated by a certain amount from the average child in spelling ability, his brother or sister would deviate from the average child just half as much, that is, he would resemble his brother or sister to that extent.

After due allowance has been made for the influence of environment, Thorndike gives it as his opinion that "what knowledge we have . . . supports the view that a man's original nature is organized by inheritance in great detail, particular traits and complexes of traits showing similarity between father and son or brother and brother." In another connection, the same author, in discussing the value of entrance examinations in college, emphasizes the importance of heredity. He states that one can get a better idea of what a student can do in his senior year of college, by finding what sort of records his older brother had made than by taking his own entrance examination record.

The belief in the inheritance of mental characteristics has received considerable support from the recent studies of mental defectives. It is always easier to trace the transmission of defects than normal traits, because of the more obtrusive character of the former. Especially clear is the inheritance of the defects resulting from incomplete or retarded structural development of the nervous system, giving such deviations from the normal as weak-mindedness, imbecility, idiocy, etc. Only one study need be cited here.

Goddard has made a study of mental defect in two lines coming from related ancestral stocks. A man of good stock had an illegitimate child by a weak-minded girl and then later married a woman of good stock who bore children. The descendants of the same father by two different mothers have been traced for a number of generations. In the case of the descendants from the offspring of the weak-minded girl there is a continuous series of incompetents, drunkards, drug users, prostitutes, etc., while the other branch of the family shows a long line of people of good standing.

What makes this case of particular value is the fact that both lines of descendants continued to live in the same neighborhood for generations. The history of the two families shows the transmissibility of mental defect, and more than this, it shows that what is transmitted is here a general mental deficiency which may show itself in a great variety

of ways depending on the specific conditions affecting different persons.

The inheritance of insanity is more difficult to demonstrate than that of feeble-mindedness, but numerous statistical studies tend to show that this, too, may be transmitted. To give one case, Mott has analyzed 18 families, in which both parents suffered from insanity, or nervous breakdown, or were suicides, and finds that 39% of the offspring were affected. In 90 families where only one parent was insane, only 9.6% of the offspring were affected.

Granting now that certain physical characteristics and conditions of high and low intelligence and possibly some more particular mental traits are inheritable, let us consider whether any specific tendencies of another kind can be inherited, such as particular diseases, the drink habit, drug habit, and the like. The balance of opinion today is against this sort of inheritance, using the term in its strict sense. But it is granted that a child may be born afflicted with disease as a result of parental infection before birth, or may be born with a constitution so low in general vitality that stimuli will be sought of the drug or alcoholic sort, in order to enable it to compete in the struggle for existence. Or again it may be born with a low vitality, with the result that it is very susceptible to disease

From the standpoint of any one individual life and its efficiency, the question of actual inheritance of disease may not seem to have so much importance,

since when one finds himself afflicted with a disease or habit no distinction between real inheritance and prenatal influence can be made. But when one considers the chances of transmission to future generations, then the distinction between inherited and acquired conditions becomes quite important. For example, if a mother is afflicted with tuberculosis, and gives birth to a child, the child may become infected with the tubercle bacillus, by way of the blood of the mother, although such cases are thought to be extremely rare. Infection of the embryo with syphilis is, on the contrary, quite common. Both of these cases are examples of prenatal infection and not real inheritance. What most frequently happens is that the embryo is interfered with in its development so that the child is born with a weakened constitution, with its vitality below par, and on this account may be highly susceptible to the tubercle bacillus or any other disease germ. An individual born in this condition is far better off than one endowed by heredity with a specific disease or habit would be. By proper living and proper selection of occupation, the former may escape many of the ill-effects of his inheritance, while the latter, being born with the condition, must either be cured or be doomed.

From the point of view of the production and development of efficient individuals, therefore, the question of family inheritance is of great importance. It demands that only individuals with the

possibility of efficient lives be born. This means such control of marriages as now exists in many states, namely, the refusal of marriage licenses in the absence of a clean bill of health and evidence of normal mentality from the contracting parties. Every state but the following eleven have enacted laws preventing marriage in case of one or more of the various kinds of deficiency, including imbecility, feeble-mindedness, epilepsy, idiocy and venereal diseases:

Alabama	Louisiana	Tennessee
Arizona	Missouri	Texas
Colorado	New Hampshire	Alaska
Florida	New Mexico	

The production of none but efficient individuals means further that individuals known to be defective shall be prevented from having offspring, a matter also regulated in some states by law. Asexualization, or the performance of operations to prevent the possibility of offspring, is provided for by law in the following states, in case of various kinds of defectiveness:

California	Nevada
Connecticut	New Jersey
Indiana	New York
Iowa	North Dakota
Kansas	Washington
Michigan	Wisconsin

In the following states bills have been proposed but lost:

Arizona	Vermont
Illinois	Virginia
Minnesota	

In Oregon a bill was passed by the Legislature and killed by a referendum vote of the people. In the states where there are laws, they usually begin somewhat as follows: "Whereas heredity plays a most important part in the transmission of crime, idiocy and imbecility. . . ." The following is an extract from a law concerning the prevention of offspring in the state of Iowa, which may serve as an example of the others:

It shall be the duty of the state board of parole, with the managing officer and the physician of each public institution in the state, entrusted with the care and custody of criminals, rapists, idiots, feeble-minded, imbeciles, lunatics, drunkards, drug fiends, epileptics, syphilitics, moral and sexual perverts, and diseased and degenerate persons, and they are hereby authorized and directed to, annually or oftener, examine into the mental and physical condition, the records and family history of the inmates of such institutions, with a view of determining whether it is improper or inadvisable to allow any of such inmates to procreate and to judge of such matters. If a majority of them decide that a procreation by any of such inmates would produce children with a tendency to disease, deformity, crime, insanity, feeble-mindedness, idiocy, imbecility, epilepsy or alcoholism, or if the physical

or mental condition of any such inmate will probably be materially improved thereby, or if such inmate is an epileptic or syphilitic, or gives evidence, while an inmate of such institution, that he or she is a moral or sexual pervert, then the physician of the institution, or one selected by him, shall perform the operation of vasectomy or ligation of the fallopian tubes, as the case may be, upon such person. Provided that such operation shall be performed upon every convict or inmate of such institution who has been convicted of prostitution or violation of the law as laid down in..........................
or who has been twice convicted of other sexual offenses, including soliciting, as defined in ....
or who has been twice convicted of a felony, and each such convict or inmate shall be subjected to this same operation of vasectomy or ligation of the fallopian tubes, as the case may be, by the physician of the institution or one selected by him.

The production of efficient individuals means the adoption of many other radical means of improving the human stock. It means that the use of the above mentioned radical measures must be extended beyond persons who are found in institutions, to include those incompetents and defectives who are at large. The type of defective known as a moron, seldom put in institutions, and yet incurably deficient, morally and intellectually, represents the group among whom offspring might be prohibited.

Here is a field where applied psychology determines the *means* of attaining efficiency. Whether the end or the purpose to which the means leads is right or not must be settled otherwise. It is

obvious that today the means of obtaining efficiency which depends upon the determination of what kind of individuals shall be born, conflicts to a certain extent with public sentiment. It is justifiable to proceed slowly in such matters, for we are constantly reminded that many of the great characters of history were defective in one or other of the ways mentioned in the preceding pages. But there is no doubt that the pressing character of the problem of deficiency will cause a more widespread limitation of production of possible burdens and menaces to society.

CHAPTER IV

EFFICIENCY AND LEARNING

We have previously discussed the tendencies of the individual toward activity before he comes into contact with his environment. Since the necessary reactions to environment begin at birth or even before, we have been forced to speak of possibilities of certain kinds of behavior or tendencies to action, meaning simply that the first time a stimulus affects the organism a particular response will follow. How are these original tendencies to action modified as a result of environmental influences, or to put the case more simply, how does one learn? We have said that all situations naturally produce a satisfying or an annoying state of mind in the individual and that the organism tends to make movements of random character to retain the satisfying state or to change the annoying into a satisfying state; further, that there is a tendency for the reactions resulting in a satisfying state to produce a more lasting effect upon the nervous system than those reactions which produce an annoying state. Hence, by virtue of these original characteristics of the organism, we

have a mechanism by which certain kinds of movements may be selected out of a number of more or less random movements and become connected or associated with a certain objective situation. If the stimulus produces a reaction which is at once pleasant, this form of response becomes easier to repeat when that stimulus is again received. If the stimulus produces a response which is accompanied by an annoying state, then the random movements occur; and the response which finally produces the satisfying state is the one which is most easily repeated when the stimulus is next received. Consequently, learning may be reduced to the formation of connections between situations or stimuli and responses or reactions. It consists in (a) the strengthening of some original responses by repeating them, and (b) weakening certain other original responses to a given situation and substituting other responses which in turn grow stronger with use.

For convenience of treatment a distinction may be made between the case in which the response consists of a bodily movement and that in which it consists of a change in consciousness, but fundamentally there is no distinction. In one case the objective change is the object of interest and in the other it is the subjective or mental change. The underlying nerve activity is of the same character in both cases. There are some investigators who assert that every response to a stimulus is a movement response, which may or may not be accompanied by conscious-

ness. Pillsbury, in speaking of the relation between habit and memory, says:

Habits, as was seen, are due to the establishment of connections between sensory and motor neurones by a change that takes place at the synapse. After these have been frequently connected, the stimulus tends to reinstate the act whenever it appears. Retention of ideas has exactly the same basis. The cells involved in the ideas also act together, and this activity produces changes in the synapses. Whenever one of the ideas presents itself again, the other is, or tends to be, reinstated. Not merely the cortical elements are rearoused in memory, but the whole sensori-motor tract may be partially active. This brings the process still nearer to habit. Memory is an habitual response in which the greater part of the activity is in the cortex. The activities of the sense-organ and the muscles are subordinated to the central processes, while in habit the whole sensori-motor tract is active in approximately the same degree.

Efficiency in Habit Formation and the Acquisition of Skill.—The objective type of learning is variously termed habit, practice, or acquisition of skill. A great mass of experimental work has been done both on animals and on man to determine the fundamental laws of habit formation. A good example of learning in animals is the case cited by Thorndike of a house cat learning to escape from a pen to get food.

If we take a box twenty by fifteen inches, replace its cover and front side by bars an inch apart and make

in this front side a door arranged so as to fall open when a wooden button inside is turned from a vertical to a horizontal position, we shall have means to observe such [learning process]. A kitten, three to six months old, if put in this box, when hungry, a bit of fish being left outside, reacts as follows: It tries to squeeze through between the bars, claws at the bars and at loose things in and out of the box, stretches its paws out between the bars, and bites at its confining walls. Some one of all of these promiscuous clawings, squeezings, and bitings turns round the wooden button, and the kitten gains freedom and food. By repeating the experience again and again, the animal gradually comes to omit all the useless clawings, and the like and to manifest only the particular impulse (e. g., to claw hard at the top of the button with the paw, or to push against one side of it with the nose), which has resulted successfully. It turns the button around without delay whenever put into the box. It has formed an association between the situation, confinement in a box of a certain appearance, and the response of clawing at a certain part of that box in a certain definite way. Popularly speaking, it has learned to open a door by turning a button.

"Learning by trial and error" is the name given to this sort of learning.

Much of the learning of human beings is of this crude sort, especially the learning of infants and young children. But even in adults the same selection of the correct movement from a number of more or less chance series of movements is the basis of learning. A young child who is learning to write will make many random movements with his hand

and many useless movements of other parts of his body, such as gritting his teeth, scraping his feet on the floor, and sliding around in his chair. When some of the movements produce a satisfying effect, through an approximation to the copy, or the approval of the teacher, these movements get the advantage over all others, so that when another attempt is made, the correct movements will tend to occur sooner. Finally, when learning is complete, only those movements which aid directly in reaching the desired result are retained.

The results of experimental studies of the learning process are summarized in the following statements:

1.—A series of more or less diffuse and random movements lead to chance success. There must be a cause for these random movements. It may be only the instinctive tendency to be active, or hunger, or interest in some specific task such as learning to write, or to solve a puzzle. Interest is the important factor in the learning of adults.

2.—The pleasurable effect tends to stamp in the successful movement more permanently than the unsuccessful, so that when the procedure is repeated, some of the incorrect and unnecessary movements are dropped off and the right one occurs sooner. In terms of time, there is a gradual reduction of the time necessary to perform the act.

3.—The influence of unpleasant effects must not be overlooked. Stimuli which are annoying lead nat-

urally to activity that will continue until a pleasurable result occurs. Thus, if it does nothing more than lead to activity, the unpleasantness would aid in the learning process, since movements of this type are just the sort that give opportunity for chance success. Compared with the direct effect of pleasurable states in establishing a habit, the unpleasant states are sometimes called secondary or indirect aids to learning.

4.—Learning, with the consequent reduction in time of performance, is in many cases due not to making the same movements faster and faster, but to making entirely different movements. That is, the habit when formed may consist of a set of movements entirely different from those employed in the beginning. Learning is thus primarily a process of selection of movements.

5.—To get a proper conception of the changes which occur in learning, the whole process must be conceived as taking place in the nervous system, i. e., it must be treated as a physiological change. It resolves itself into a modification of certain conduction units in the nervous system so that a certain stimulus will lead directly to a certain movement. Thus any factors which tend to establish such paths of conduction in the nervous system are of use in learning. Of these factors, two of the most important are repetition of the stimulus and increase in the magnitude of the stimulus.

6.—It is generally agreed that learning must be

spontaneous. And this conclusion naturally follows if our explanation of learning be correct. If one is to learn an act of skill, he must make the movements himself rather than watch another make them, or rather than have his own limbs passively moved by another. Since training is a preparation of sensori-motor conduction paths, the complete paths must be exercised, and this occurs only in active movement. Guiding a child's hand in teaching him to write would then be an inefficient method of instruction.

The acquisition of skill depends upon the same conditions as those just cited. Very careful and detailed studies have been made upon the acquisition of skill in typewriting, in telegraphy, in target shooting and other similar activities. The most recent and complete of these experimental studies is that on typewriting. In this experiment every error made and the time required for every single operation of the machine were recorded during the course of the learning process. The introspections of the learners were recorded at frequent intervals to aid in interpreting the causes of improvement. The following conclusions to be drawn from this work supplement those derived from the study of the more elementary form of learning described above.

7.—The methods by which improvement comes are seldom conscious,—one falls into the right way of doing things without knowing what the change is. Anyone who has learned to play tennis, golf, to skate or to swim, will recall that very often he did not

know or could not discover just what constituted the modification in his procedure which changed the unsuccessful into the successful trials. The reason that the successful variations may not be conscious is that the learning consists in changes in the physiological mechanism, hence it would be impossible for one to be conscious of anything but the outward results of the change. In the case of typewriting, certain steps in the process of improvement were discovered. The improvement has been attributed to the "formation of higher units" or the acquisition of larger and larger groups of movement habits. These are series or chains of movements which are set going with as little conscious control as one single movement requires in the untrained person. Thus a skilled typist writes whole groups of letters and even words with one conscious effort, rather than one letter at a time, although each letter always requires a specific movement. So it is that an expert operator can move his fingers in writing faster than they can be followed by the eye, or even faster than they can be followed in thought.

8.—After a certain set of responses has once been developed, it is often of value to become conscious of them in order that they may be repeated the more readily when needed. For example, the ability to write certain combinations of letters on the typewriter without attention to the letters comes gradually, and one is surprised to find himself able to do it. To use such higher units efficiently the writer

should be conscious of these newly acquired habits, so that he may distribute his attention to the greatest advantage.

9.—Improvement often results from the elimination of bad habits, the dropping off of useless movements. In most cases these, too, are unconscious changes, which may be discovered after they have been established. Watching a beginner learn any complicated act will reveal a great number of useless and retarding movements, which must be eliminated as practice continues. The greatest efficiency results from learning under such guidance that only *right* habits can become fixed. The value of this is especially clear in typewriting, where one's common sense will not guide him into the most economical procedure, and where if left to himself, one will form habits which must be broken with more or less difficulty before further progress can be made. It is largely on account of the value of forming right habits from the very beginning of the learning process that instruction has come to play such a large part in the scientific management program.

10.—The typewriting experiments show the great value of incentive in helping one to improve. The promise of promotion, the promotion itself, or a desired reward of any kind, will often give the needed spur to one's energy. In the case of telegraphy, men will remain for years at a fixed degree of efficiency, until some unusual stimulus will cause

a striking increase in speed. Obviously, such spurs to effort come relatively seldom, but there is a source of interest and incentive available to all learners. That is the incentive which comes from competing with one's own past record. Such self-competition has most of the good points of actual competition and rivalry with one's fellows—which have a strong instinctive basis,—with none of its bad points. Any person who will carefully keep a record of a series of his trials in acquiring skill, either in terms of amount of work done, or time required to do it, and will draw the results out in curve form will develop great interest in building the curve from time to time and noting its changes. The value of self-competition is being recognized in school work in connection with the "practice method," where such individual records are kept by the children, and in industrial work, where an individual works by the piece method and a record of his daily or hourly achievement serves as a strong incentive to increased effort.

Kirby used the practice method of teaching arithmetic to a group of 1,300 New York City school children, and compared their records with children taught in the ordinary manner. The children were further compared as to length of their practice periods. In discussing the experiment, Kirby thus emphasizes the importance of knowledge of one's past record as an incentive:

After a practice period was finished and pencils were laid down, the children were eager to tell their own scores and to learn the scores of others. It acted as an immediate reward and so as an incentive. . . . Just before beginning the second and each following practice period, the exact score of each child in the preceding day's practice was read, both the number of columns worked and the number correct. . . . The children were told that their individual improvement was to be measured and they were shown that no matter how low or how high their present record, their final standing would be determined by the amount of gain made. They were shown that it was not primarily a contest among the individuals of the class but an effort on the part of each one to surpass his own previous record. The children were encouraged to compare their last record with their own previous records, and at times the scores were read to them in such a way as to indicate gains made.

In accounting for the greater improvement in the group whose practice time was divided into rather short working periods, he says,

The group working in shorter periods had a longer time in which to catch the spirit of the experiment, and to become enthusiastic over surpassing their previous performance. They had their own records read to them more times and had the incentives to intense effort repeated more often.

Experimental results indicate that there is no act, except a reflex, no matter how specialized the training may have been in the course of one's occupation, that cannot be improved by practice, under the conditions of the so-called "practice experiment."

Typesetters of years of experience are able to improve considerably under practice conditions, and bank clerks who have added figures for years can make striking increases in speed in a few hours of self-competition. The practical application of these facts is obvious.

11.—There is a "physiological limit" beyond which our bodily mechanisms will not allow us to go either in speed or in amount of work. Thus the delicacy of our sense organs limits the fineness of our sensory discrimination, the structure of bones and muscles limits our strength, and the conducting mechanism, including the nerve fibers and their central connections, limits the speed with which our movements may follow the stimuli or situations which cause them. For instance, the physiological limit for a movement of the finger in response to the stimulation of the eye by a light of moderate intensity is about one-tenth of a second. But in the great majority of cases, it is not the physiological limit which blocks progress. Most often it is the lack of sufficiently powerful incentives, the presence of wrong movement habits or other remediable condition. According to James, most of us get into the habit of living on too inefficient a plane, and could increase our output largely without taxing our organism to the danger point. He says,

Of course there are limits, the trees don't grow to the sky. But the plain fact remains that men the world over

possess amounts of resource which only very exceptional individuals push to their extremes of use. But the very same individual, pushing his energies to their extreme, may in a vast number of cases keep the pace up day after day, and find no reaction of a bad sort, so long as decent hygienic conditions are preserved. His more active rate of energizing does not wreck him; for the organism adapts itself, and as the rate of waste augments, augments accordingly the rate of repair.

Just how one may know his real limit beyond which it is not safe to go, will be discussed in a later chapter.

Efficiency in Memory.—In distinction from the objective form of learning or habit formation, there is the subjective learning or memory. This last is a general term commonly used to cover all such phenomena as retention, recall, association and recognition. The results of the large amount of experimental work on memory may be gathered into a few statements, showing the most economical methods of learning. We are not likely to feel the necessity for economy and efficiency in our mental activities, because we do not commonly think of them as consuming energy. But when one realizes that time and energy are required as much as in bodily activity, the need for economy is apparent.

1.—The most efficient learning consists in selecting the particular type of memory adapted to a given kind of material and the use to which it is to be put. The schools in their work emphasize the most diffi-

cult kind of memory, an unaided verbatim reproduction. There are certain cases that require this type of learning, e. g., all isolated materials such as the multiplication tables, and the spelling of words. But there are other kinds of material which should be easily obtainable when needed, but which need not be carried in the mind at all times. In such cases one need not learn so completely that the facts may be recalled at any time but only well enough that they may be relearned easily when needed. Thus most of our knowledge acquired in our school days has apparently gone completely from our minds, but only a small percentage of the original labor will bring it all back. Much of the education of the engineer, the professional man and the teacher is of this kind.

Then there is much material which need be learned only so well that it will be recalled along with some other definite thing with which it has been associated. The name of a person may be thus associated with the sight of his face, a telephone number with a particular name, a foreign word with the sight of the English equivalent. This type of memory requires much less effort than absolute recall and in its place is just as efficient.

Some things need be remembered only when they themselves are present. This form of memory is called recognition, and it is the most economical of all. It consists simply in knowing a thing or being familiar with it, when we meet it. For instance, it

is far more important for one to know his fountain pen when he sees it, to be able to use it, than to know all about it at other times. In what way and how well a thing is to be learned must depend on the use that is to be made of it, for economy of effort demands that the means shall be employed which will be most efficient with the least expenditure of energy.

2.—If a large quantity of material is to be learned, common sense will not enable one to select the most economical method of learning it. Experiment has shown that the material should be learned as a whole rather than in parts. To take an example, if one had a poem of sixteen four-line verses to learn, the correct way to learn it would not be to learn it one verse at a time, a procedure commonly followed by an untrained individual, but to read from beginning to end again and again until the whole could be repeated. There is only one drawback to this method, namely, that a person is likely to become discouraged or lose interest when progress is apparently lacking, if he does not have sufficient confidence in the method. It sometimes happens that in first using this method of learning, rather poor results are obtained, but if given a fair trial, the time saved and the greater permanence of the result will show the real efficiency of the method.

The reason for the greater economy of the "whole method" lies in one of the most fundamental laws of learning, namely, that one should always begin by

doing a thing as nearly as possible in the way it is eventually to be done. Otherwise, it must not only be relearned in parts, but old habits must be broken. In learning anything in sections, associations are formed between the end of a section and its beginning, but since repetition as a whole is the desired end, all of such associations must be finally broken and correct ones formed. Learning the task as a whole in the first place forms only habits which will be needed in the perfected performance.

3.—A third fact in economical learning has to do with the distribution of time and effort. If the exact influence of fatigue, practice, and a number of other factors involved in learning were known, one could arrange beforehand the time schedule that would be most economical for learning. But since we do not have such knowledge in sufficient detail, the problem has to be attacked empirically. Various tasks are set and a given amount of time allowed for learning. This time is differently distributed for different individuals, some spending theirs in one continuous work period, and others spreading their time over a period by dividing it into portions. The conclusion which has been drawn from experiments of this type is that too great concentration or distribution of time is not economical. The learning periods should be short enough to avoid the onset of fatigue, and long enough not to cause the loss of too much time in getting warmed up to the task at the beginning of each learning period. No abso-

lute rule can be laid down for all individuals, but it can be safely said that a moderate distribution of time always gives more economical results than spending the same amount in one continuous study period. The same facts are true of motor learning or muscular activity. The reason in the latter case seems more obvious than in memorizing, but it is no doubt the same in both cases. Activity causes an increase in the nutrition of the part used, and these nutritive changes, whether they occur in the nerve or in the muscle mechanism, would be most furthered by a distribution of the working time.

4.—The permanence of the effects of learning has been measured for various sorts of material and for fairly long periods of time. Naturally, the duration of the effect of learning depends much on the character of the material, e. g., whether or not it is logical in character, and whether or not it is related to one's permanent interests. But allowing for all of these possible variations, the effects of learning fade out in relatively the same manner, whatever the nature of the material learned. Thus, it has been definitely established that forgetting goes on very rapidly for a short time after learning and then more slowly until the passage of months or even years does not seem to reduce the quantity retained. A necessary corollary to these facts about forgetting is that of the value of repetition in learning, or reciting from time to time what has been learned. The most economical time to do this repeating is

during the period shortly after the learning, because this is the critical period in which a large proportion of the material, if not refreshed, will be lost. The laboratory experiment which indicates the slowest rate of forgetting, shows that, of a poem learned well enough to be repeated correctly twice immediately after learning, over 20% will be lost in 24 hours; while at the end of 30 days only 76% will be lost. These figures mean that in a period thirty times as long, less than four times as much of the material is lost. The results of other experiments with different kinds of material show a much greater difference in the rate of forgetting during the different time intervals.

5.—One of the most important conclusions drawn from experimental work on learning is the necessity for the intention or the "will to learn," in order that things shall be remembered. The case is analogous to the active as compared with the passive attitude in habit formation mentioned earlier in the chapter. Anyone can find abundant evidence from his own experience that only the things which he wills to learn are likely to be remembered. For instance, the writer has in the course of certain experimental work named a series of 100 colors (five different colors, each repeated twenty times, arranged in a random order), over 1,000 times in order to measure his speed of reading, and he never learned the list so far as to be able to recall even the first three colors. Here the intention was to gain

speed in reading and not to remember. One's ignorance of situations which he meets daily during years of his life testifies to the importance of this intention to learn. The inability to describe correctly the face of the watch which has been carried for years and looked at many times each day is one striking example.

6.—Just as there is a physiological limit to our speed of action or our endurance, so there is a limit to our learning power, set by the original character of our nervous mechanism. What one's training does is to enable him to make the best use of his native memory, by teaching him the value of various aids to memory such as we have been discussing in these pages. Original differences in retentiveness may account for the great individual differences in the memories of adults.

The Function of Imagery in Learning.—There is no one question concerning consciousness in which people seem to differ more than in the importance they attach to images or mental pictures in learning and thinking. Some persons have very vivid imagery and find it present in consciousness so consistently that they make memory and the presence of images of past experience practically synonymous. To such persons, one way to improve memory and learning power is to cultivate a rich and detailed mental imagery. To others, such imagery is almost unknown and consequently seems valueless for mental operations. To Francis Galton and

many others since his time, people seem divisible into types according to the character and richness of their imagery. The most significant fact in the work of Galton is the relative paucity of images found in scientific and abstract thinkers, and its great prominence in children.

A question of particular importance to the applied psychologist concerns the value of imagery for special kinds of work. For instance, does the inventor need vivid visual imagery so that he may see in his mind's eye the thing that he shall construct; do the painter and the sculptor need vivid and detailed imagery from which to copy their creations; does the musician need to have auditory imagery to create and reproduce music; is any workman benefited by his ability to get good mental pictures of his task and his attitude toward it? It is difficult to draw a perfectly definite conclusion as to the practical function of imagery. But careful investigations indicate that persons lacking these images altogether, or possessing them in such vague form as to make them seem useless, have been eminent in the activities mentioned above. Furthermore, individuals who can demonstrate that they rely on these images in learning are rare. So far as the present state of our knowledge permits us to judge of the matter, it would seem to be a waste of time to cultivate imagery as an aid to learning or as a source of mental efficiency. And it would be absurd to select individuals for special types of work

upon the basis of their imagery, either as to its character or its vividness.

Transfer Effects of Training.—In studying efficiency in mental life one frequently encounters this question: Is there a general ability or intelligence which is trained and developed in the course of experience, or is training specific in its effects, modifying only the function exercised? Our educational systems have been built upon the assumption that there is a general intelligence which is subject to improvement, and that such studies as algebra, Latin and Greek are especially valuable for this general training. Exact measures of the effects of training in simple mental and motor activities, supported by the modern conception of the function of the nervous system, tend to support the view that training is specific, affecting only the function exercised. The problem is a rather complex one, since a function like memory as we speak of it in a practical sense may correspond to a large number of separate functions in the nervous system. The methods of studying this problem of transfer may be illustrated by the description of an experiment recently reported. From a series of 500 numbers, persons were practiced for ten days in canceling out every 3 and every 5 from a page of digits. They had been previously tested for their speed in canceling from a series of number-groups, every group containing combinations of 3 and 5, and combinations of 4 and 7. After the ten days' practice in

canceling 3 and 5 separately, the group cancellation tests were repeated. It was found that in the canceling of the groups containing 3 and 5, there was a gain equal to more than 50% of the gain in the task actually practiced, that is, the transfer effect was 50%. But in canceling groups containing 4 and 7, there was no gain whatever to be attributed to practice. In the one case we find identical elements, the numbers 3 and 5, responsible for the transferred improvement, and in the case of the numbers 4 and 7, there were no identical elements, and no improvement. This means that there was no improvement in the general ability to cancel numbers, but only in the ability to cancel specific numbers or groups of numbers. This particular experiment and its results are typical of those performed by numerous investigators.

In response to the growing conception of the limitations of general training, one can see a natural reaction in the educational procedure, a reduction in the emphasis upon purely cultural studies, with an increase of emphasis upon vocational and practical aspects of training.

The problem as it should be stated today, is not whether specific training spreads to all other functions, but to what extent, and whether the amount of spread is sufficient to warrant the time and energy spent in general training. No complete solution has been reached to cover all cases, but there is a conclusion which may be safely drawn, namely, *that one*

gets the best results from practicing the act he wants eventually to perform, and in the way that he wants to perform it, and is benefited by other related acts only so far as there are common elements in the two acts.

Influence of Practice Upon Variability.—There is an important question concerning the effects of uniform training upon differences among individuals. Does uniform training make people more alike or more different than they would have been without it? The question as stated would be answered differently by persons who attach much or little importance to heredity as compared with environment. To the former, training or practice would only give opportunity for original qualities to show themselves, and hence would result in increased differences; while to the latter, similar training would produce greater uniformity. The matter has been attacked experimentally, in the case of very simple mental operations, such as calculations and speed of perception, but the results are difficult to interpret. Differences at the beginning of training may be due to differences in the extent to which the particular function has been previously trained, or to actual differences in original capacity to learn. The effects of practice would be different in the two cases. If the differences at the beginning of practice are due to inherited capacity, then practice would increase these differences; but if the differences before practice are due to differences in train-

ing, the individual with little previous training would be given the opportunity to acquire it, and the individuals would become more similar. It is practically never possible to evaluate the factor of previous training in experimental tests, since no one ever begins training in any function at the zero point of efficiency, nor can it be assumed that two or more people begin the training with the same preliminary preparation. About all that the practice tests show thus far is that the relative position of the individuals of a group at the beginning of practice does not necessarily indicate what their relative order will be at the end of practice. The one who begins best, may, at the end of practice, be the best, or may drop to an inferior position and be supplanted by one who began with an inferior grade of performance. This is especially the case where practice continues until ultimate ability is approximated. The variation in position is due to the interaction of previous training and original capacity, and perhaps also to such factors as change in the attitude of the individual toward the work, or loss of interest. Expressed in terms of coefficients of correlation, reported by Thorndike, the relation between relative position at the beginning and end of practice is for a group of 28 persons tested in mental multiplication .48; and by Hollingworth the same relation in the case of a number of simple mental tests on a group of 13 individuals is .42. This latter figure is the average of separate correlations, and the author emphasizes

the fact that the different tests included in the group do not all show the same relation. The relation between beginning and end of practice represented by a correlation of .40 to .50 indicates changes in position about half as great as would occur by pure chance.

The practical conclusion to be drawn from this type of experimental work is that one should be cautious in judging ultimate capacity of an individual from any sort of preliminary test. The conclusion agrees with one quoted from Thorndike earlier, that the college marks of one's older brother in his senior year are a more reliable index of what the individual himself will do in his senior year, than are his own college entrance examinations.

A further question may well be asked, concerning the influence of practice upon the variability of each individual's performance. It is well established that practice decreases the variability of an individual, makes his performance more uniform. In fact this may be considered a matter of common observation. The variability is reduced by trimming off all superfluous and wrong movements, leaving fewer factors to vary. But even when this has been done, variations in performance are not completely eliminated; there will always be slight variations in speed and accuracy. The question then arises whether there is an actual reduction in the variation of the movements still retained as a part of the performance, or whether the reduction is only apparent

and due to the elimination of the useless movements. In studying this matter, statistical errors are likely to creep in, since if variability is calculated on the basis of the time required, it is much reduced by practice, but if calculated on the basis of quantity done in a given time, the variability increases with practice. In concluding as to the change in the character of one's work as a result of practice, the figures must not be taken at their face value, but must always be interpreted in the light of the method of deriving them.

CHAPTER V

INFLUENCE OF SEX AND AGE ON EFFICIENCY

Sex.—There is one more inherited characteristic which must be considered in a study of efficiency, namely, sex. It is inherited from our immediate ancestry, although the factors which determine sex are not yet understood. To what extent does one's sex predetermine efficiency in practical life? Does being a male or a female imply the possession of certain original characters which make one or the other incapable of certain kinds of useful activity? This is an extremely difficult question to answer, on account of the characteristics which the sexes acquire from their early training, and on account of the fixed traditions which have been cultivated concerning the proper occupations for men and women. Custom has certainly been a very powerful factor in determining what shall be the sphere of the sexes. Just because the sexes are never subject to the same environmental conditions, there is scarcely any opportunity to study their differences in original nature.

The practical question of relative capacity of the sexes is being answered to a certain extent in the warring countries because the scarcity of men has

forced women into many of the positions formerly occupied exclusively by men. In two years' time we have grown accustomed to hearing of women iron workers, women street car conductors and motormen, women farmers and women chauffeurs. And they seem to be efficient in these tasks. What will be the effect of this work in the course of time upon women and their offspring remains to be seen.

The question of sex differences can best be handled by considering, first, the physical and the physiological and then the mental characteristics of the sexes. Physically, women have a smaller average size and weight of the body as a whole, and of parts such as the skull, and trunk. Men are uniformly stronger than women and more so than the difference in bodily size and weight would warrant. The difference is to be attributed at least partly to intrinsically stronger muscles, rather than to differences in their development. The most striking difference in structure and functions, however, is in what are called the primary sex characters. Thus the anatomy and the physiological mechanisms of women are adapted to the bearing and the rearing of children, whether they ever have them or not. In connection with this primary sex function, all females have been thought to be handicapped by their periodical functions, which incapacitate them both physically and mentally for a certain time each month, and on this account women have been considered as excluded from many of the professions

and occupations open to men. The same argument has many times been used against coëducation. A certain amount of physical disability may be granted. But recent and careful experimental study of mental and motor ability over long periods of time has failed to show any rhythmic variation in ability or performance, and has tended to refute the older views as inapplicable to normal healthy women. Some interesting statistics are available concerning the efficiency of women in industry. In a work published by the Russell Sage Foundation in the interest of labor legislation, it is stated that women suffer especially from present day conditions in industrial work, such as overstrain from excessive speed and complexity, prolonged standing and the absence of a monthly day of rest.

In addition to their susceptibility to injuries of the generative organs, working women have been found more liable than men to disease in general. There is a consensus of opinion among those who have longest observed girls and women at work, that the burdens of industrial life press more heavily upon them than upon men. Wherever statistics of the morbidity of both working men and working women exist, the morbidity of women is found to be higher. . . . The two most important facts to be noted are women's higher morbidity when compared with men in the same occupations, and their longer duration of illness, measured by the number of days lost from work. . . . Thus are women physiologically handicapped by a greater general liability to disease, and a peculiar susceptibility to injuries of the generative organs. In a

word, they are less resistant to fatigue than men, and their organisms suffer more gravely than men's from the strains and stresses of industrial life.

Such facts as these may well be questioned when presented as evidence of natural sex differences, for in the case of working women there is often the burden of looking after the home in addition to the industrial labors, which is not borne by the men. In short, not only similarity of industrial conditions must be taken into account, but all other differences in the environment outside of working hours must likewise be considered.

Are there any innate mental qualities peculiar to each of the sexes? Perhaps the most important differences to be looked for would be those of instinctive equipment. Can any differences in instinctive equipment be discovered? There are two instances mentioned by Thorndike, namely, differences in the pugnacity or fighting instinct and in the parental instinct. The former is said to be much more prominent in men and the latter in women. If such native differences really exist they will account for much of the difference between the sexes, e. g., the great prominence of men in the field of competitive activities and of women in the moral qualities resulting from her natural tendency toward parental activities. It is no simple matter to decide upon the relative strength of these two instinctive tendencies in men and women, because as general concepts the meaning of the terms is not definitely de-

termined. And further, the environmental differences may be such as to give prominence to the different tendencies in the two sexes very early in life, although they may be originally equal in strength. There is little agreement among authorities concerning any other instincts in which the sexes might differ.

Are there any natural differences between the sexes in general intelligence? This question may be answered by studying the records of tests of mental characteristics little affected by training. Thorndike has collected the most important data concerning sex differences in mental ability. These are given in the accompanying table. The figures represent, in the case of each trait, how many males are as good as or better than half of the females (or what per cent of the males reach or exceed the median of the females). For instance, in the case of the tests for spelling the table shows that only thirty-three per cent of the men attain a degree of efficiency attained by fifty per cent of the women. In all cases the records are the result of laboratory tests, except where they are noted as derived from school marks.

	Name of Test	Per cent men reaching median of women
1.	Color Naming and Card Sorting	24
2.	Cancellation Tests	33
3.	Spelling	33
4.	English (School marks)	35
5.	Foreign Languages (School marks)	40
6.	Immediate Memory	42

Name of Test	Per cent men reaching median of women
7. Sensory Threshold	.43
8. Retentiveness	.47
9. Association (Speed and accuracy)	.48
10. General Information	.50
11. Mathematics (School marks)	.50
12. School Marks (Average of all studies)	.50
13. Discrimination (Other than color)	.51
14. Range of Sensitivity	.52
15. History (School marks)	.55
16. Ingenuity (Special tests)	.63
17. Accuracy of Movement (Of arm)	.66
18. Physics and Chemistry (School marks)	.68
19. Reaction Time	.70
20. Speed of Movement (Finger and arm)	.71

These records are collected from various sources and represent different degrees of reliability. The twenty traits may be roughly divided into three groups, namely, those traits in which women excel (1 to 7); those traits in which the sexes are equal (8 to 14); and those traits in which men excel (15 to 20). An examination of these three groups may give some grounds for certain differences generally attributed to the sexes. For instance, women appear to be better in language work, and men in science work, women rank higher in sensitivity and men in activity. But the overlapping of the sexes in these traits is just as significant as the differences. And, further, one cannot exclude the possibility that these differences, such as they are, may have other than a hereditary basis.

Men and women may be said to differ in ways not measured by these mental tests, for instance, in emotionality, impulsiveness and sympathy. Although these characteristics cannot be measured in the same way as some of the simpler mental qualities, still they may be investigated in less direct ways. Some results have been reported which are based upon the judgments of the two sexes by friends, teachers, relatives and acquaintances. Such measures of characteristics based on this type of judgment conscientiously made are subject to inaccuracies, but still give a more reliable picture of sex differences than the casual impressions or prejudices that usually form the basis of opinion. Thorndike has worked over all available records of this sort and has presented them so as to show the per cent of men reaching or exceeding fifty per cent of the women in each trait. For instance, in the case of patience, thirty-eight per cent of the men are found to have the degree of patience found in fifty per cent of the women. The traits studied and their values follow:

Name of Trait	Per cent men reaching median of women
1. Interest in Persons Rather Than Things	15
2. Emotionality	30
3. Temperance	30
4. Impulsiveness	34
5. Religiousness	36
6. Sympathy	38
7. Patience	38

Name of Test	Per cent men reaching median of women
8. Vanity	.40
9. Shyness	.42
10. Temper	.56
11. Self-Consciousness	.57
12. Humor	.61
13. Independence	.70

In practically all of these characteristics, as in the groups of traits previously described, there is a great overlapping of the two sexes. It is quite likely also that some of the differences which are shown may be due to the different standards in the traits which custom decrees for men and women, that is, the differences may be due to environmental rather than to hereditary factors.

There are still other possibilities of differences between the sexes. One of these is a difference of variability within the two groups, which, if found to be the case, would be a very vital difference. For instance, if men were found to be the more variable sex, in the sense that men covered a greater range of performance, then the best and the worst human beings would be men, and the fact that men have figured more prominently in the deeds of the world would be accounted for in the original constitution of the sexes. Likewise, if this were true, the highest achievement in the future could be expected from men.

A rather common opinion among scientific men has been that men *are* more variable than women in this sense. The view was first contested by Karl

Pearson and since that time the earlier studies have been examined more critically and much evidence has accumulated which casts doubt on claims of differences in variability between the sexes. When unfavorable environmental conditions are allowed for, and sufficiently large numbers of individuals are tested, differences in variability do not appear. Three sorts of evidence have been presented by a recent writer in an attempt to dispose of the problem of sex variability:

1.—Physical measurements of newborn infants of both sexes. This is perhaps the only case where innate variability of the sexes can be compared, unmodified by environmental influences, since by the time that mental tests can be given the latter factor may have changed the innate tendencies. Hollingworth and Montague studied careful physical measurements of 2,000 newborn babies, 1,000 of each sex, and failed to find any significant differences in the range of variability in the two groups in the characters measured. Pearson studied physical characteristics of adults of both sexes and he too failed to find any differences in variability.

2.—Mental tests of the two sexes. The most recent studies of large groups of people of the two sexes fail to show any differences in variability in the abilities tested. Among such studies may be mentioned that of Trabue on 13,000 school children in the completion of sentences, the arithmetic tests of Courtis on several thousand children, the Binet-

Simon tests made by Terman on 1,000 children and Pyle's extensive measurements of school children.

3.—Statistical studies of mental deficiency in the two sexes. Such studies made by institutions for the feeble-minded and defective show at first glance that there are more men than women admitted to these institutions. Since this is just what should be expected if men were more variable than women,—men being both better and worse than women,—such data have been used in support of the contention that men are more variable than women. But a closer study of the significance of the figures, together with consideration of the forces that bring cases to institutions for the defective, shows that the two sexes are affected unequally by these forces. Defective women are much more likely to be maintained outside of institutions than men, because they are essentially a dependent and non-competitive class, hence do not succumb in the economic struggle. As far as range of variability of the two sexes is concerned, the above arguments give no good grounds for assuming a difference.

We may conclude our survey of the relation between sex and efficiency with the following statement from Thorndike:

> The most important characteristic of these differences is their small amount. The individual differences within one sex so enormously outweigh the differences between the sexes in these intellectual and semi-intellectual traits that for practical purposes the sex differences may be dis-

regarded. So far as ability goes, there could hardly be a stupider way to get two groups, alike within each group but differing between the groups, than to take the two sexes. As is well known, the experiments of the past generation in educating women have shown their equal competence in school work of elementary, secondary and collegiate grade. The present generation's experience is showing the same fact for professional education and business service. The psychologist's measurements lead to the conclusion that this equality of achievement comes from an equality of natural gifts, not from an overstraining of the lesser talents of women.

Age.—The influence of age upon physical and mental capacity is universally recognized, and yet the popular conception of age qualifications of all sorts is neither definite nor uniform. In practically no case is there good scientific foundation for the social, business and industrial age requirements. The economic factor may seem to be important in determining the age qualifications for work of various sorts. For instance, the labor of boys and girls is usually cheaper than that of adults, while the employment of old persons is not advisable because they are likely to be inefficient, and their employment may involve their care after they cease to be useful. A few examples of age qualifications follow:

1.—Certain railroads will not employ men over the age of 35 years, and have a pension system whereby they are automatically retired from service at the age of 65-70 years.

2.—In some states no person under the age of sixteen may drive an automobile, although the writers know of no case where there is an upper or old age limit for such work.

3.—Entrance to college is frequently limited to persons over a given age, e. g., 15 years.

4.—Applicants for police service must be over 18 years of age (sometimes 21).

5.—The vote is limited to adults 21 years of age or older. Under that age men are infants in the eyes of the law, requiring a guardian for the transaction of legal business.

6.—Persons under the age of 14 (sometimes 16) cannot be employed in industrial work.

7.—Children under five years of age may ride free on most public carriers, and children under the age of 12 years may ride for half of the adult fare.

8.—The so-called age of consent varies from 12 to 16 years in different states.

For many of these and other age qualifications there appears to be no sound reason. Why should the legal age be 21 years rather than 18 or 25 years; why should an intelligent fifteen-year-old boy be prohibited from driving an automobile, while a feeble man of 70 is not restrained? The whole conception of age requirements seems to be based upon the idea that chronological age is a real measure of physical and mental qualifications, or that there is a uniform change in individuals with age, so that number of years lived will serve as an index of fit-

ness. The reliability of this age index of capacity must be determined by investigation.

The physical and physiological changes with age may be divided into two groups: First, those relatively rapid and pronounced changes, the date of whose occurrence is fairly uniform in all people, such as the appearance of the teeth, making possible a change from liquid to solid food, the maturing of the sexual mechanisms from 12 to 17 years of age, known as the adolescent period, and the menopause in women between the ages of 45 and 50 with its important physical and physiological changes. Second, there are the gradual and continuous changes in structure and function which occur from the moment of birth to death.

The body increases rapidly after birth in size and weight. It is the popular idea that the rate of growth increases up to maturity and then declines as old age advances. As a matter of fact, careful examination of the facts shows that the rate of growth decreases from birth to old age, although not uniformly. At the pubertal period and at other times its downward tendency may be arrested for a time. But, speaking generally, the maximum rate of growth is reached some time during the intra-uterine period, and after birth the curve falls steadily. Senescence has begun to appear at the time we are born. . . . The signs of old age may be detected in other ways than by observations upon the rate of growth. Changes take place in the composition of the tissues; these changes, at first scarcely noticeable, become gradually more obvious as old age advances. The bones become more brittle from an increase in their inorganic salts, the cartilages become more

rigid and calcareous, the crystalline lens gradually loses its elasticity, the muscles lose their vigor, the hairs their pigment, the nuclei of the nerve cells become smaller, and so on. In every way there is increasing evidence, as the years grow, that the metabolism of the living matter of the body becomes less and less perfect; the power of the protoplasm itself becomes more and more limited, and we may suppose, would eventually fail, bringing about what might be called a natural death. As a matter of fact, death of the organism usually results from the failure of some one of its many complex mechanisms, while the majority of the tissues are still able to maintain their existence if supplied with proper conditions of nourishment.[1]

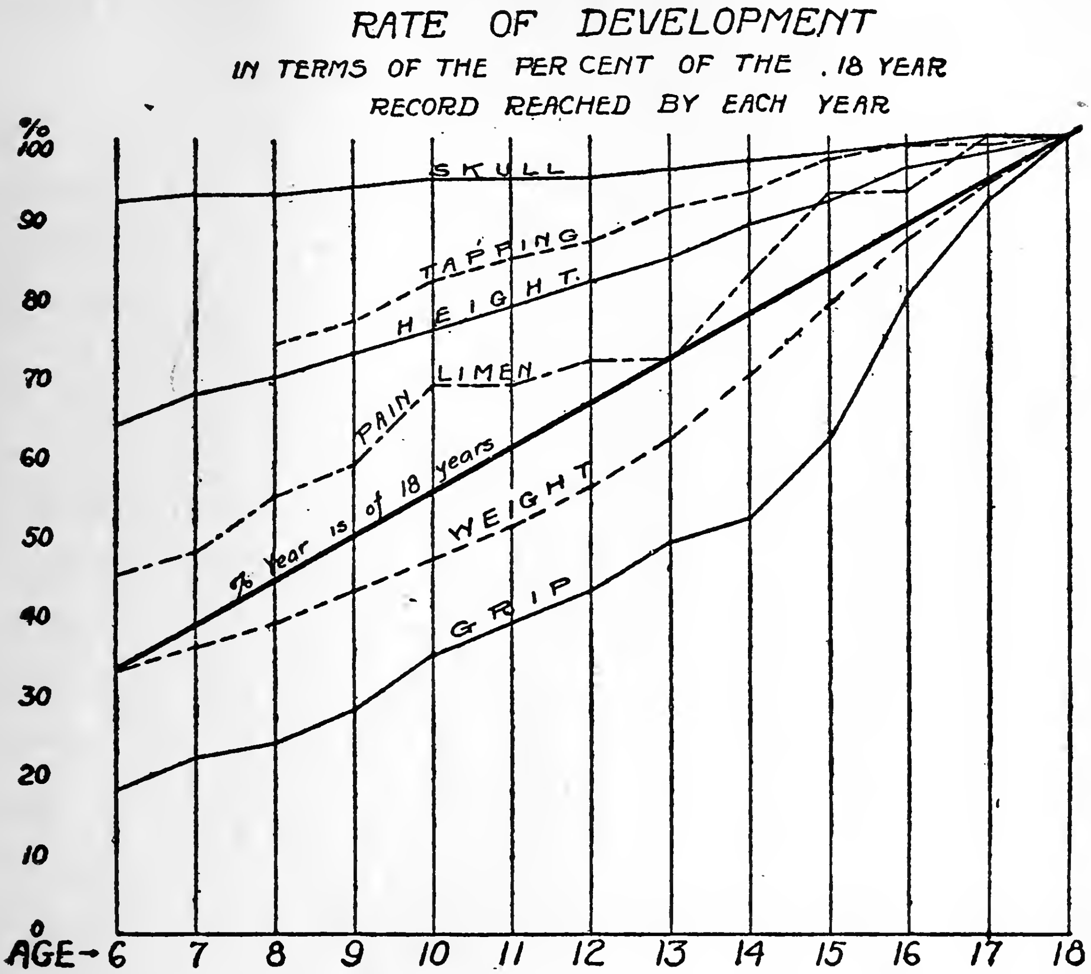
The special mechanisms which most commonly fail are the heart, blood vessels, the kidneys and the lungs. Now these changes are not so closely correlated with the number of years that one has lived that years may be taken as a sign of physical age; the failures are more likely due to accident or to manner of living than to age. Examples of this lack of correlation between physical condition and age in years are abundant. Many a man of 70 years is physically younger than others of 45. Realization of such disparity is leading to the development of new physical age standards. One's age may now be measured in such terms as blood pressure and kidney action, rather than in years, months and days. That "a man is as old as his arteries," has become a popular expression. A recent campaign for the employment of old men as office help, clerks

[1] Howell, W. H., "Textbook of Physiology" (1908), p. 904.

and messengers to offset the scarcity of labor, would be quite justifiable if coupled with the physical examination of all candidates and the selection of those chronologically old but physically young.

Careful measurements emphasize not only the great individual variations in physical and physiological development with age, but also the variation in the rate of development of different characters in the same individual. The accompanying curves indicate the different rates of change in a few physical characters, height, weight, length of skull, strength of grip, speed of movement (rate of tapping with finger), and sensitivity to pain. In order to make the data comparable, all age values for the different measurements are expressed in terms of the value at 18 years of age, which is taken to represent 100. Measurements of this sort have not been systematically made beyond the age of 18 years. The figures along the base line show the chronological age, and those along the vertical show the per cents of the 18 year values. Differences in the shape of the curves will indicate differences in rate of development. For instance, the length of the skull changes only slightly but very uniformly from 6 to 18 years. Strength of grip, on the contrary, undergoes considerable change, with an increase in rate at the age of 14 years, the adolescent period. Between these extremes various rates of change may be noticed. Each curve may be compared with the straight line which

represents the change in age upon the basis of 18 years as 100.



The following table gives the 18 year values for each of the traits as well as the units of measure for each. In the first column are the traits, in the second, the unit in terms of which the measurement was made, in the third, the record for 18-year-old boys and girls, the values representing the average of the records for the two sexes.

AVERAGES OF PHYSICAL TRAITS AT THE AGE OF EIGHTEEN

Trait	Unit of Measure	Average Value
Height	Centimeter	165.0
Weight	Kilogram	57.0

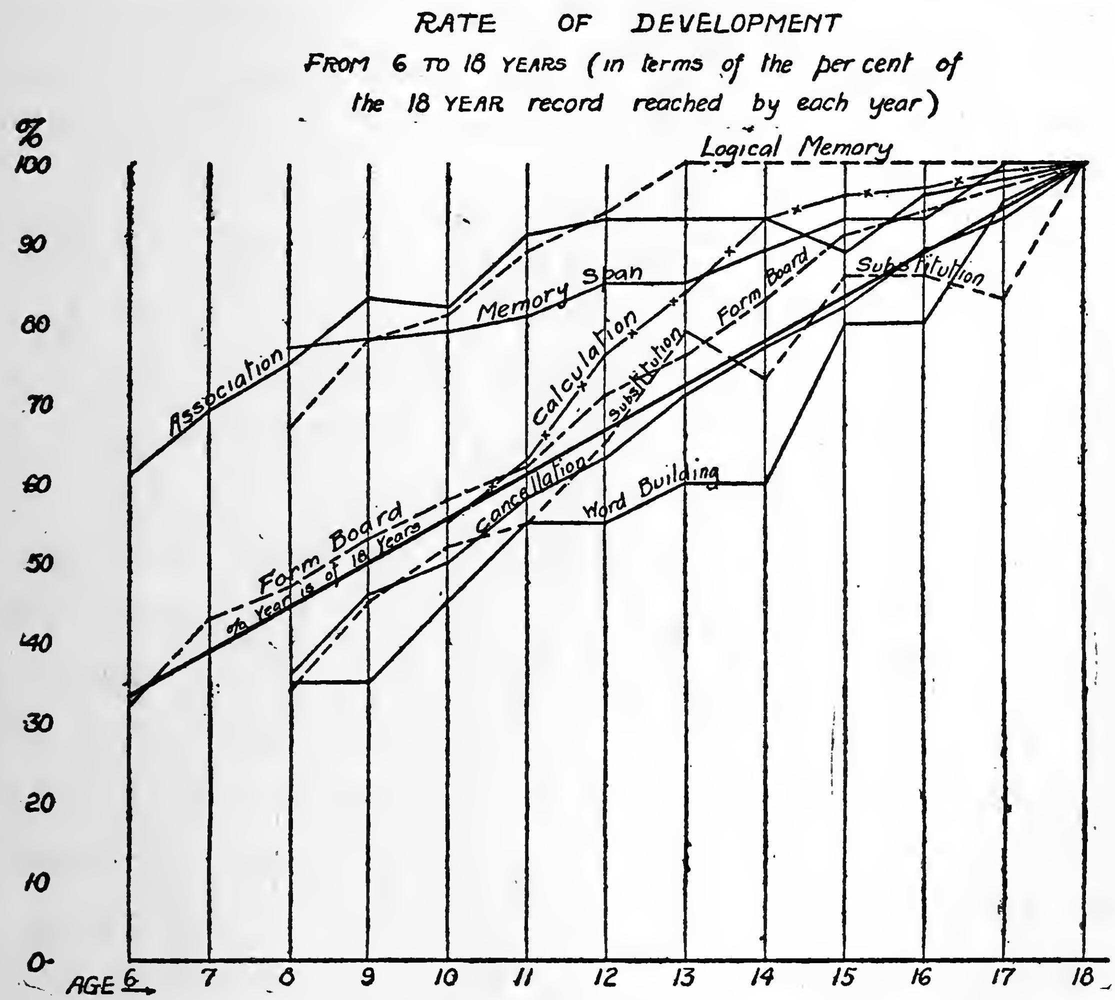
Trait	Unit of Measure	Average Value
Skull Length	Millimeter	189.0
Strength of Grip	Kilogram	39.5
Tapping Rate	30 seconds	195.0
Pain Threshold	Kilogram	1.9

The study of the individual differences in physical and physiological characteristics for a given age shows that environment, and special habits of living are more vital than mere maturity in determining bodily condition. Hence, the struggle to keep physically young with increasing years, if properly conducted, will within limits have its reward.

Mental condition like physical condition undergoes rapid changes at certain periods. The mental is usually correlated with the physical so that the two periods of most profound mental change are adolescence in boys and girls and menopause in women. The adolescent period has been the object of much study, because the time of its occurrence makes of it an educational problem. Then there is the gradual mental development with age. The intelligence tests of the psychological laboratory have disclosed interesting relations between age and mental development, both in the nature of differences among individuals and in variations in different functions within the same individual. It has been found, for instance, that instead of all of the mental functions developing at the same rate, there is great variation, even in such functions as rote memory and logical memory. The laboratory tests have been

limited largely to persons of school age, since for educational purposes mental growth during this period is of most interest.

The accompanying chart will give some indication of the relative rate of change of a few mental functions. In order to make the data of the different mental traits comparable, they have been treated in the same manner as the physical traits described



earlier, that is, the records for age 18 have been taken as the standard and the other ages are represented in terms of per cent of this 18 year record. Examination of the chart shows that logical memory reaches a maximum at 13 years of age with no

change up to 18 years, while rote memory (measured by memory span) shows a more gradual increase with its maximum about 17 years. Certain of the traits, e. g., word building, indicate an increasing rate of improvement from 6 to 18 years, while others, e. g., association, show a decreasing rate of improvement. The straight line represents the age change in terms of 18 years as 100, or the standard. To determine the rate of change of a trait, its curve should be compared with this age curve.

The figures for the different traits at the age of 18 are given in the accompanying table, together with the unit of measure for each trait. Each figure represents the average record for boys and girls. From these figures and by reference to the curves, the values for each age may be determined.

Averages of Mental Traits at the Age of Eighteen

Trait	Unit of Measure	Average Value
Memory Span (Digits)	Items	8.6
Logical Memory	Items	37.5
Substitution	Items	29.5
Cancellation	One Minute	22.5
Word Building	Five Minutes	19.5
Associations (Common)	Per cent	90.0
Form Board	Seconds	10.0
Calculation	One Minute	58.0

There is even greater disparity between age in years and mental growth than between the former and physical growth. If one is physically in his prime at 25 years of age, he may reach his mental

zenith at 60 years or older. A great deal of emphasis has been given to the disparity between age in years and mental development by the mental tests of Binet-Simon and others, and the term "intelligence coefficient" has been coined to express the relation between them. From these tests one can assign to an individual a mental age in years by comparing his performance with the so-called age norms. Thus, if a 16-year-old boy makes a record in the tests such as the average 10-year-old boy makes, his mental age is 10. The intelligence coefficient is this mental age divided by the chronological age. A coefficient of 1.00 would then indicate a person mentally normal, or one as much developed as the average person of his age, a coefficient of .75 would indicate one below the average and a coefficient of 1.25 would indicate a person above the average intelligence for his age. "It is by no means uncommon to find seven-year-olds who can do intellectual work at which one in twenty seventeen-year-olds would fail." And it is still less uncommon to find a twenty-five year old person with the mental age of a boy of twelve. Obviously then, for most practical purposes it is mental age rather than chronological age which is important. These age scales for the determination of mental ability have been devised for the detection of mental deficiency, and only of late have been modified to cover ages above twelve years. It may in time be possible to measure the intelligence of any adult in terms of an intelligence scale.

CHAPTER VI

ENVIRONMENTAL CONDITIONS

I.—Ventilation: Temperature and Humidity.—The condition of the air in which one lives has been recognized as a factor in efficiency since the 17th Century. The tragedy of the Black Hole of Calcutta, more than one hundred and fifty years ago, has frequently served as an example of the effect of lack of ventilation. The following is taken from a recent article in *Popular Science Monthly* (1914), upon "Fresh Air."

One of the hottest of the hot nights of British India, a little more than one hundred and fifty years ago, Siraj-Uddaula, a youthful merciless ruler of Bengal, caused to be confined within a small cell in Fort William, one hundred and forty-six Englishmen whom he had that day captured in a siege of the city of Calcutta. The room was large enough to house comfortably but two persons. Its heavy door was bolted; its walls were pierced by two windows barred with iron, through which little air could enter. The night slowly passed away, and with the advent of the morning death had come to all but a score of the luckless company. A survivor has left an account of the horrible happenings within the dungeon, of terrible strug-

glings of a steaming mass of sentient human bodies for the insufficient air. Within a few minutes after entrance every man was bathed in a wet perspiration and was searching for ways to escape from the stifling heat. Clothing was soon stripped off. Breathing became difficult. There were vain onslaughts on the windows; there were vain efforts to force the door. Thirst grew intolerable, and there were ravings for the water which the guards passed in between the bars, not from feelings of mercy but only to witness in ghoulish glee the added struggles for impossible relief. Ungovernable confusion and turmoil and riot soon reigned. Men became delirious. . . . All efforts for relief were vain until at last bodily and mental agony was followed by stupor.

One need only appeal to his own experiences for proof that being confined in a crowded, poorly ventilated room produces drowsiness, lassitude, and even severe headache or fainting. To correct the evil, it is not enough to blame the bad air,—one must know just why the air is bad,—what makes it bad. Mere opinion and popular prejudice cannot be relied on to discover the cause, but the results of scientific experiments must be sought. Fortunately, in recent years a great deal of investigation has been going on to answer this question. The most recent and comprehensive experiment is that now being conducted by the New York State Commission on Ventilation, in their laboratories at the College of the City of New York. Our conclusions will be drawn largely from reports of this work.

One of the earliest explanations of the effects of

bad air, before chemical analysis of the atmospheric air had been made, was that the human body exhausted the aërial spirit of the air, a substance necessary for the preservation of life. Another view was that the human body gave off noxious vapors which poisoned those persons inhaling them. After the analysis of air into its chemical constituents the aërial spirit needed to preserve life became oxygen and the noxious gases became carbon dioxide. The effects of bad air were then thought to be due to the decrease of oxygen and the increase of carbon dioxide components of the air. This is the view that is prevalent in the popular mind today. Experimental work, however, does not support this theory. Pure air contains among other constituents in small proportions, the following:

oxygen	21	per cent
nitrogen	78	" "
carbon dioxide	0.03	" "

Now in the most poorly ventilated schools and factories the oxygen is reduced to only 19% and the carbon dioxide is increased to only 0.3%. But in order that any harmful physiological effects can be demonstrated, the oxygen must be reduced to 14 per cent and the carbon dioxide increased to 2.4 per cent. It is clear from such figures that the ill effects from poorly ventilated rooms cannot then be attributed to reduction in oxygen nor to increase in

carbon dioxide, nor even to a combination of both.

The theory of "crowd poison," as it was called, next developed and received much support even as late as 1911. According to this theory organic matter given off by the lungs and the body surface contained a poison, called anthropotoxin. The odor of foul air was supposed to be an index of the presence of this poison. Definite proof of this theory seemed to be obtained by condensing expired air and administering the solids and liquids obtained to guinea pigs. Ill effects thus produced were attributed to the presence of the anthropotoxin. Later experiments showed that the technique of these tests was in error and that the conclusions were false.

Moreover, experiment has shown that air is almost never responsible for carrying disease germs of any kind. When transmission by way of dust particles, by insects, and by actual contact has been eliminated there is little transmission of disease germs. Lee, a prominent physiologist, speaks as follows concerning infection by way of the air:

The mere fact that such germs (as tuberculosis, diphtheria, typhoid fever, dysentery, etc.) have at times been found (in the air) is of little significance in the matter of possible aërial infection. They never occur in any considerable numbers, and considerable numbers of germs are usually necessary to produce disease. It is known that many bacteria on being cast out into the air from an infected source lose their virulence in the process of drying, and soon die. Evidence that these disease germs pass

through the air from room to room of a house or from a hospital to its immediate surroundings always breaks down when examined critically. It is, indeed, not rare now to treat cases of different infectious diseases within the same hospital ward. The one place of possible danger is in the immediate vicinity of a person suffering from a disease affecting the air passages, the mouth, throat or lungs, such as a "cold" or tuberculosis. Such a person may give out the characteristic microbes for a distance of a few feet from his body, not in quiet expiration, for simple expired air is sterile, but attached to droplets that may be expelled in coughing, sneezing or forcible speaking. But apart from this source, there appears to be little danger of contracting an infectious disease from germs that float to us through the medium of the air.

Infection from sewer gas escaping from defective plumbing is a negligible quantity in the transmission of disease. Workmen in sewers are notoriously strong, vigorous, healthy men, with a low death rate among them.

In the work of the ventilation commission thus far, the only result of the presence of organic substances in the air has been a slight loss of appetite, not accompanied by unpleasant feelings or reduction in work done.

If bad air is not bad on account of its chemical constitution, low oxygen content, high carbon dioxide content, or the presence of toxins, what is the cause of the indisputable ill effects of poor ventilation? Chemical theories have been replaced by physical theories, and the problem is transferred from chemistry to physics. The air is considered as a radiating medium by which the body may maintain

a so-called normal temperature, set by nature at 98.6° F. When the temperature rises above this normal the subject is said to have a fever, or when it sinks below this normal, he has a "chill." Either condition is destructive to the bodily well-being, the life of the individual cells depending on a maintenance of this norm.

Fever is accompanied by abnormal chemical changes within the tissues and the production of toxic substances, which in turn react upon the tissues, diminishing their working power, inducing early fatigue, and upsetting the normal equilibrium of the organism. The result of such a disturbance of the bodily mechanism, if very pronounced, is the production of a pathological condition which is called heat stroke.

The body is constantly producing more heat than is necessary for maintaining this normal temperature, as a result of muscular, nervous and glandular activity. The excess is given off partly by way of the warm expired air, but largely by radiation from the body surface and by evaporation of the perspiration thrown out upon the skin by the sweat glands. These two processes of radiation and evaporation depend not only upon the body and its condition, but also upon the condition of the air surrounding the body. If, for instance, the temperature of the air is higher than that of the body, direct radiation from the body to the air would not occur, but rather the opposite. Further, if the air is already saturated with moisture, evaporation can-

not occur. In this state the two most important factors in maintaining a normal body temperature are absent, and the body suffers from overheating. It is this overheating which causes the lassitude, drowsiness, headache, etc. Thus it may be said that the two most important conditions of the air in which one is required to live, which demand attention, are temperature and humidity, and not chemical constitution.

Experimental results bear out these statements. If a number of individuals are kept in an air-tight room with the air unchanged for a number of hours, they show the usual symptoms of poor ventilation. If they are allowed to breathe fresh air by means of tubes leading from the outside of the room these symptoms do not disappear. And if an individual on the outside of the room is allowed to breathe the much used air from within the room, by means of tubes, he does not show the symptoms. Hence the air breathed is not the cause of the discomfort. The experiment room, used by the New York Ventilation Commission, is equipped with devices for changing the air in any fashion, e. g., temperature, humidity, stagnancy, etc., and the effects of each change may be determined. Any change which will produce the necessary radiation of heat from the body has been found to reduce the unpleasant symptoms. Thus stirring or disturbing the air with electric fans, thereby driving the hottest air away from the skin, will bring relief at once.

Thus far we have spoken of the feelings of discomfort, etc., resulting from poor ventilation. What is the effect on efficiency as measured in quantity and quality of work done? The efficiency tests of the Ventilation Commission are still in progress, but the available data show that if temperature and humidity are kept at optimum values, lack of ventilation does not decrease either mental or physical efficiency. If the temperature and humidity are raised, there is falling off in physical efficiency. For instance, the tests thus far made show that the efficiency at 68° is 37 per cent greater than that at 86° F., and 15 per cent greater than at 75° F. As for mental work, represented by mental multiplication, association, addition, typewriting and the like, there is no distinct falling off in efficiency, even when temperature and humidity are considerably raised. But in this case when the subjects were allowed to follow their own inclinations, the mental efficiency was perceptibly reduced; that is, they were less inclined to work. This probably means that the tasks were more difficult and unpleasant and consequently required more effort when the temperature and humidity were high.

Humidity must always be considered in relation to the temperature. The optimum humidity increases as the temperature increases. For as air is heated it is capable of holding more moisture and as it is cooled it will give off some of its moisture—its saturation point is raised or lowered by change

in temperature. It must be kept in mind that air which is too low in moisture content is not good, as it will take more moisture from the body than it can spare, and dry throat and nasal passages will result.

The following practical conclusions may be drawn from the foregoing:

1.—Homes and offices should be kept at a temperature no higher than 70°. The following additional figures are given by American ventilating engineers:

Occupants at Rest		Occupants Physically Active	
Lecture Halls	61-64	Gymnasium	60
Sleeping Rooms	54-59	Work Shop (moderately active)	61-64
Bath Rooms	68-72	Work Shop (vigorously active)	50-59

With a temperature of 68°, the humidity should be about 60°. The wet bulb thermometer gives a record of temperature and humidity combined, and a reading of 60 on such a thermometer is recommended.

2.—Enclosed air should be kept in motion. This may be done by fans or by a current of air from an open window. Driving the overheated air from the surface of the body promotes evaporation and reduction of high body temperature.

3.—Draughts are harmful only when limited to a small part of the body such as the back of the neck or the ankles. General changes of temperature are invigorating and resemble a cold bath in their effect.

4.—Have plenty of fresh air night and day. With otherwise poorly ventilated rooms this is the surest way of keeping the temperature and humidity what it should be. All enclosed air spaces when occupied by people rise in temperature and humidity from body heat and moisture, conditions which can be counteracted by a free circulation of air from the outside.

II.—Climate and Season of the Year.—Climates differ from one another, and seasons likewise, in four respects; namely, temperature, humidity, barometric pressure and wind. The influence of climate and season of the year, consequently, reduce largely to a question of temperature and relative humidity, and to that extent are covered by the previous discussion. But some consideration must be given to the statistical researches upon the influence of climate and season, if only to corroborate the experimental results. Aside from differing in the method of obtaining the data, the two sorts of study, namely, that on ventilation and that on climatic conditions, differ in that the latter are concerned with the supposed results of subjection for long periods of time to certain atmospheric conditions, and the former with results for relatively short periods. The following quotations are taken from the writings of E. G. Dexter who has done a great deal of statistical work upon the general problem of weather conditions and from that of E. Huntington, who has studied the effects of climate upon civilization.

In their effects upon the race . . . varying temperatures have been recognized by every student of climatology. Inhabitants of hot climates are apt to be listless, uninventive, apathetic and improvident. An equable high temperature, especially if moist, weakens body and mind. No long-established lowland tropical people is a conquering race in the broadest sense of the word. For the inhabitants of the higher altitudes, even under the tropical sun, this may not be true; for as we ascend, the temperature lessens about 1 degree every 270 feet on an average, and even at the equator we may have a temperate climate. The most favorable temperature for health that carries with it an aggressive energy which is felt, and which has led the world march of civilization, is about 55 to 70 degrees Fahrenheit, on an average, and this is found in the temperate zones. . . . The dominant peoples are found between the latitudes of 25 and 55 degrees. Farther north the available vital energy seems so largely expended in furnishing mere body heat and stimulus for the necessary physiological functions that there is little left for use in those activities which make leaders. . . . Excessive heat together with high humidity forms a most deadly combination for one not acclimated to it, as the mortality on the west coast of Africa testifies; while in some localities, as for instance, Western Ireland, the lake region of England, and the extreme northwestern coast of our own country, much moisture from a great rainfall without excessive heat is not particularly unhealthful.

One objection to giving such great importance to climatic conditions in determining the character of civilizations has been the changes in the type of civilization that have taken place in the course of centuries in the same locality. To offset this objec-

tion, however, there is the suggestion, supported by modern researches, that climatic conditions have varied from century to century, and that "when the great countries of antiquity rose to eminence, they enjoyed a climatic stimulus comparable with that existing today where the leading nations now dwell. In other words, where civilization has risen to a high level the climate appears to have possessed the qualities which today are most stimulating."

So far as the behavior of the individual is concerned, climatic conditions which are extreme in neither direction are conducive to the greatest activity. That is, in extremely warm and humid climates and in extremely cold climates, the excess of energy supply over demand is always slight, and activity of all kinds is at a minimum. To put the matter another way, so as to relate it to our study of ventilation more closely, any atmospheric conditions which tend to change the body temperature much above or below its normal for more than a very short period of time decrease activity.

It must be remembered that great activity and large reserves of energy on which the activity depends may be turned to good or bad use. Thus Dexter attributes the excess of crimes such as murder, assault, etc., in the temperature zone, over that in the torrid or frigid zone, to this excess of energy and consequent activity. He also finds a great excess of such active crimes as assault in the summer months as compared with the winter months. On

the other hand, he finds much more drunkenness in the winter season, a condition which he attributes to the low state of energy and the consequent need for stimulants. The excess of activity seems to find the readiest escape by way of the emotional states that lead to fighting.

An interesting fact in connection with the relation between the curves representing temperature and those representing frequency of assaults (the latter being taken as an indication of excess energy), is that they run parallel except in exceedingly hot weather, i. e., from 90° F. up there is a drop in the curve, which means a decrease in number of assaults. This confirms the earlier statement that high temperatures as well as low ones reduce the energy supply available for activity. Huntington considers England and the northwest coast of the United States as approaching the ideal climate. The former, in the neighborhood of London and Liverpool averages 38° to 39° F., in winter and 60° to 63° in summer; the latter (e. g., Seattle) averages 39° in January and 64° in July. He attributes the climatic excellence of these localities to the fact that ocean winds from the west blow freely over them. Dexter measured the effect of season of the year upon intellectual work of a rather specific sort; namely, the calculations of bank clerks. The records were in terms of certain types of errors made. He found most errors occurring in October, November and December, and fewest in April, May and September,

with the number fairly large in the hot summer months. The last he considers due to the depletion of energy from excessive heat, the good records, or few errors, in the spring and autumn due to the stimulating character of the changes in temperature. The high error record in the winter months cannot be attributed to weather conditions solely, as the whole matter is complicated by increased business, holiday seasons, etc.

III. Weather.—Weather may be reduced to the same four conditions as climate, namely, temperature, humidity, barometric pressure and wind, the main difference being in the temporary character of weather conditions as compared with climatic conditions. On account of this variety greater opportunity is offered for study of various conditions upon efficiency. Climate is always involved with such a large number of other conditions, among them racial heredity, that conclusions are uncertain. The influences of the weather may be studied upon the same individuals under environmental conditions identical except in regard to this one factor.

The following quotations taken from an article on the "Psychic Effects of the Weather," give a notion of the common opinions about the effects of weather conditions:

Nearly all vocations—some, of course, more than others—are affected by weather. Men of science are often as much subject to weather as seamen. Some writers must

have the weather fit the mood, character or scene, and can do nothing if they are at variance. An adverse temperature brings them to a dead halt. If one will but read poetry attentively, he will be surprised to find how much of it bears weather marks scattered all through it. A popular writer thinks weather often affects logic, and many of men's most syllogistic conclusions are varied by heat and cold. Diverse weather states may be one cause of so much diversity and even disagreement in thought processes, usually regarded as scientific. I have collected opinions of many experienced teachers and nearly all think there should be modification of both school work and discipline to correspond with weather. Animals respond to it promptly and with no restraint, and almost constitute a sort of weather signal service if observed. . . .

An employer of 3,000 workmen is quoted as saying he "reckons that a disagreeable day yields about ten per cent less work than a delightful day," and we thus have to count this as a factor in our profit and loss account. Accidents are more numerous in factories on bad days. A railroad man never proposes changes to his superior if the weather is not propitious. Some men say that opinions reached in the best weather states are safest to invest on.

Huntington has studied more than 500 factory workers in Connecticut and 3,000 to 4,000 operatives from the Southern States. He has examined the records of 1,700 West Point and Annapolis students and correlated their work on various days with the weather conditions on those days. His conclusions are as follows:

1.—Changes in barometric pressure have little effect.

2.—Humidity possesses a considerable degree of importance.

3.—Temperature is the most important factor. The greatest physical activity occurs when the daily temperature averages 60° to 65° with a noon temperature of about 70°. Mental activity reaches a maximum when the outside temperature averages about 38°, that is, when there are frosts at night. Moderate temperature changes from day to day are most conducive to activity, while great uniformity or sudden great changes are detrimental to good work.

The measurements by Dexter, mentioned above, on the effects of the season of the year upon certain specific mental activities, namely, the calculations such as bank clerks are called upon to make, and discriminations, or tests of speed of perception, are of interest in connection with our discussion of weather conditions. His results will be briefly quoted, although it must be clear that the conditions studied reduce primarily to those now under investigation by the ventilation commission. The latter work done under controlled conditions and with carefully planned technique should be given relatively great weight in drawing conclusions.

1.—Increase in temperature causes an increase in errors, the increase becoming very rapid when the temperature reaches 85° to 90° F. At this point the excess reaches 60 per cent over the average.

2.—Increase in barometric pressure increases the

number of errors. Here the data are not so satisfactory and the conclusion rather indefinite.

3.—High humidity especially when accompanied by high temperature causes increase in the number of clerical errors.

4.—An increasing high wind causes a decrease in number of errors. Dexter's explanation of this is as follows:

> It seems to me probable that it is an evidence of the necessity of ventilation on a large scale, such as is caused in our large cities through great movements of the wind. Such movements bring fresh air from the surrounding country to take the place of that which has been deoxygenated through combustion of all sorts, and the effects which we have shown are just what might be expected, for that oxygen is necessary to mental alertness no one can doubt. ("Weather Influences," p. 238.)

5.—The effects of the general character of the day are of interest. Cloudy days are accompanied by greater inaccuracy and rainy days show the same effect. Answers to a questionnaire led Dexter to conclude that the best mental work is done on fair days, while many bank officials are said to have observed an increase of errors in unpleasant weather.

After this consideration of the data, it seems fair to reduce climatic, seasonal and weather conditions due to temperature, humidity, barometric pressure and wind, to the two conditions of temperature and humidity. Winds and barometric pressure in its

causal relation to winds affect the body much as stirring the air of an enclosed room, by facilitating evaporation and heat radiation, with the consequent lowering of the body temperature. Where there is a tendency toward high body temperature there is an abnormal burning up of energy-producing material, and where there is low body temperature, there is an automatic increase in physiological activity to raise the temperature, with the consequent consumption of energy. In either case the energy available for work is reduced, and this condition may account for all of the effects of poor ventilation previously described.

IV. Influence of Daily Rhythm.—The question of change of efficiency during the course of a day may be discussed in this connection. Two questions need to be answered: First, is there a rhythm in the physiological mechanism, nervous or muscular, which, independently of work done, would affect the physical and mental efficiency of an individual? Second, in the course of continuous activity are there uniform changes in efficiency as a result of this work during the course of a day? The latter question will be touched upon in our later discussion of fatigue.

1.—To answer the first question many of the bodily processes, such as temperature, pulse, breathing, etc., have been measured at various times during the day, and a certain rhythm has been observed. For instance, temperature, pulse and breathing rate

are said to be lowest in early morning, 5 A. M., and increase gradually, reaching a maximum about 5 P. M. The death rate at various periods of the day has been taken as an indication of changing vitality or efficiency of the bodily mechanism. It has been a rather common opinion that death, excluding accidental death, of course, is most frequent at the early morning hour, 4 A. M., and consequently it has been assumed that vitality must be lowest at that time. As a matter of fact careful study of death statistics shows that the lowest death rate occurs in the early morning and the highest rate in the afternoon hours from 2 to 6, just when the physiological activities seem at their maximum. Other factors besides the bodily rhythm must therefore be sought as the cause of the peculiar distribution of deaths during the day.

Efficiency of the motor and mental processes at various periods of the day was studied by Marsh. In the case of physical strength, not including endurance, the minimum efficiency occurs at the extremes of the day, with a point of high efficiency about 11 A. M. and a point of maximum efficiency from 3 to 5 P. M. As to rate of movement there is a gradual increase in efficiency during the course of the day with the maximum toward night. In accuracy of movement the maximum efficiency occurs toward noon. Increased nervous state during the course of the day would account for the increase of speed and the decrease of accuracy of movement.

An interesting difference appears whenever mental activity is involved. Wherever motor activity is combined with the mental work as in reaction time, form board tests, and the like, the course of efficiency follows that of the motor processes, with speed reaching a maximum late in the day, and accuracy in the late morning hours. In the more strictly mental activities, such as memory, translation of foreign languages, attention, discrimination, mathematical calculation, school examinations, etc., the highest efficiency is attained in the morning hours for both speed and accuracy.

A large number of adult students and authors were questioned concerning the time of their maximum efficiency, and the majority considered it to be in the morning hours. Preference of working hours, however, may represent largely the influence of habit, rather than any actual difference in efficiency. Thus students attending classes constantly during the day may get the habit of working at night and feel less efficient at any other time. Individual choice of working hours may be further influenced by such factors as age, sex, fatigue, etc.

Such differences of efficiency in the course of a day if established beyond question would be of considerable value for practical work. Perhaps the most direct application can be seen in school work, where mental work would be done best in the morning hours and motor activities best in the afternoon hours. But many applications of the facts might

be made to industrial activities also. A test of the output of magazine stitchers whose work is motor, with speed an important factor, showed that in the early morning hours the productivity was about 6 per cent below the average for the day, and 10 to 12 per cent below the maximum efficiency for the day, which occurs toward late afternoon. Thus if the working day of magazine stitchers were to be shortened, it should be shortened at the morning end of the day where efficiency is lowest.

2.—Is this rhythm of efficiency discussed in the preceding paragraphs due to the nature of the physiological mechanism, or is it due to the relation between the hour of the day and the amount of work which has been done up to that time? In other words, is this daily efficiency curve after all only a work curve?

This leads us to our second question, namely, concerning the course of efficiency during a day of continuous work. The tests made by Hollingworth upon ten individuals for a period of ten days, two days of which consisted of twelve hours, each of practically continuous work, offer the best material for answering this question. His general conclusion is that the efficiency at any period of the day depends not on any organic rhythms, but rather upon the amount of work or activity which has preceded that period. For when the work begins at 10:30 A. M. the same sort of curve of efficiency for the day is obtained as when it begins at 7:30 A. M., except

that it is shifted ahead just that much. One could not suppose that the rhythmic organic processes independent of work done or fatigue produced could thus shift. The contrast between the period of maximum efficiency for motor and mental activity appears in Hollingworth's, as in Marsh's, results. The data further show that subjects doing work essentially mental in character and working under uniform conditions, with a maximum of interest and incentive, show an average decrease, from the maximum efficiency, of 10 to 15 per cent in the course of a day's work. This result appears only after the possibility of improvement by practice has been eliminated. The experiment by Hollingworth is practically the only one of its kind covering a long period of time which eliminates the complicating factor of practice effect, and consequently, considerable value must be attached to these conclusions, in comparison with those experiments where practice was not eliminated.

Although experimental work does not demonstrate a perfect relation between certain rhythmic bodily processes and mental and motor efficiency, it does show that mental work reaches its maximum in the morning hours and motor work, including speed and strength, exclusive of endurance, reaches its maximum late in the day. The question of motor accuracy, represented by the steadiness of the hand, in maintaining a given position is still uncertain as the two experiments quoted differ in their conclusions.

CHAPTER VII

ENVIRONMENTAL CONDITIONS (*Continued*)

There is another group of environmental factors quite as important for personal welfare and efficiency as those discussed in the preceding chapter. One of the most important of these conditions is illumination. The increase in manufacturing and industrial work requiring close visual control, the increase in the volume of reading matter and its accessibility to all people, and the improvement in the means of artificial lighting all contribute to increase the importance of illumination as a factor in efficiency. The improvements in artificial lighting devices have not only tended to cause the substitution of artificial light for daylight but have tended to increase the amount of night work where only artificial illumination is possible.

A great variety of problems has been presented to the illumination expert. Some of them have been answered by careful experiments and some are still unanswered. For the psychological aspects of illumination, reference will be made largely to the work of Ferree, who has conducted many researches

designed to answer such questions as the following:

(1) How do daylight and artificial light compare in value for vision? (2) What are the best daylight conditions for work? (3) What is the best kind of artificial lighting? (4) What is the proper location of lights with relation to the worker? (5) What are the effects of improper and insufficient illumination? (6) How shall the relative value of different kinds of light be measured? (7) Is the best light for the finest work also the best for less fine but long continued work? (8) How bright should light be for the best results? (9) Does colored light have any practical value as compared with white light?

The most effectual lighting methods are conditioned by certain characteristics of the visual mechanism, which are innate and consequently common to all human beings. A description of these characteristics will clear the way for a discussion of illumination problems. First among these conditions is the instinctive tendency to turn the eyes toward bright objects in the field of vision, so that the light shall cast an image upon the center of vision, which is the region of clearest vision upon the retina. This turning of the eyes is synonymous with visual attention; it appears soon after birth and is one of the first signs of the infant's attention to its surroundings and its discrimination of objects. Not only does it appear early, but it is never completely overcome. The actual movements may be inhibited, not, however, by a failure of the muscles to contract,

but as a result of the voluntary contraction of antagonistic muscles. Any attempt, then, to prevent this instinctive act of attention, if it succeeds at all, requires extra muscular effort voluntarily controlled, and consumes energy.

The second important characteristic of the visual mechanism is the nature of the sensitivity of the retina to light. The main point to be noted in this connection is that the retina differs considerably in sensitivity in its different parts. It is commonly supposed that because one can see most distinctly when looking directly at any object, that the part of the retina thus concerned, the so-called center of vision, is also the most sensitive. This, however, is not the case, for the region around the central one is much more sensitive to light intensity. The difference may be best described by saying that the peripheral parts of the retina are always adjusted for dim or weak lights, while the center of the retina is always adjusted for bright lights. So true is this that the center of vision with which one sees best in bright lights is practically blind in dim light, while the peripheral parts are used for vision in its place. This rather striking fact may escape our observation, yet a very simple experiment will at least give an indication of it. If one watches for the stars to appear as darkness descends in the evening, he is surprised to discover them first out of "the tail of his eye"—that is, he sees them first in indirect vision, or with the sensitive peripheral

region of his retina. What are the consequences of this adjustment of the peripheral retina for very weak lights? Everyone knows the unpleasant effects experienced upon coming from darkness into a very bright light,—a temporary blindness, or if not that, an uncomfortable glare which rather quickly disappears. Now the peripheral portions of the retina are always in this relatively sensitive state, comparable to that of the central portion of the retina after fifteen minutes in darkness. Bright lights falling upon the eyes from the side produce an uncomfortable glare.

A third characteristic of the eye is the tendency of the accommodation mechanism always to adjust itself so as to see clearly or focus properly upon the object which is being looked at or attended to. So just as there is a tendency to turn the eyes towards a bright object in the visual field, so is there a tendency to focus upon it in order to see it clearly. This is either an instinctive reaction or it is acquired extremely early in life, and is almost impossible to overcome, as anyone knows who has tried to learn to fixate a given near object while attempting to pay attention to another more distant object. There is thus a constant conflict between the tendency to accommodate for the object of involuntary attention and the object voluntarily looked at.

A fourth characteristic is the contrast effect produced when neighboring parts of the retina are stimulated with lights of different intensities or

colors. For instance, when a dark and a light object are viewed side by side, the white looks whiter and the black looks blacker than if seen alone. In a word, the contrast effect is always in the direction of the greatest opposites, a white object producing black contrast, a red object producing a green contrast, etc. This phenomenon is especially pronounced upon the peripheral parts of the retina, hence a bright object seen in an otherwise dark field has its brightness enhanced and as a result of this an uncomfortable glare is produced.

From a consideration of these four characteristics of vision, we can derive one of the most fundamental and yet one of the most often violated laws of illumination, namely, *that the whole visual field should be as nearly uniformly lighted as possible.* If a person is reading in a room with a ceiling light and unscreened side lights along the walls, each one of the latter forms a bright image or a glare spot upon the sensitive peripheral part of the retina. Contrast effect with the darker background tends to make this image appear even brighter than it is. This stimulation arouses the reflex tendency to turn the eyes toward the light source, and at the same time the tendency to change the accommodation of the eye from a near point to a far point. One of three effects will be produced: the reflex responses will occur, with the consequent distraction of the attention from the book; or they will be inhibited as a result of the contraction of antagonistic muscles,

at the expense of considerable strain and effort; or there will be a continual fluctuation in direction of the eyes and their accommodation from the book to the distracting light. This muscular strain will produce pain in the eyes and head, nervousness and general fatigue, in addition to the discomfort due directly to the glare.

It is largely the value of uniformity of illumination which makes natural lighting, or daylight, more efficient than artificial lighting, because with the former an even distribution of light is more likely to be attained without intention. Yet here there may be a lack of uniform distribution. Wrong location of the windows and skylights, incorrect shade of wall coverings and window shades and the presence of polished surfaces from which the light may be reflected may all serve to reduce the value of natural light. Most of these faults may be corrected by simple means, such as the use of ground glass in windows, removal of polished objects or giving them a dull finish, and painting the walls a soft yellow or gray. For instance, if the walls are very dark, as with blackboards in schoolrooms, then there is so much difference in the intensity of the direct light from the windows and the reflected light from the walls, that the uniformity of distribution of light is destroyed, and the evil glare effects of contrasting surfaces appear. The polished nickel trimmings of a typewriter or its glossy white keys

are sufficient to add much to the strain and fatigue of a few hours' work.

It is with artificial lighting that the most flagrant disregard of this rule of even distribution occurs.

> In lighting from exposed sources it is not infrequent to find the brightest surface from 1,000,000 to 2,500,000 times as brilliant as the darkest; and from 300,000 to 600,000 times as brilliant as the reading-page. These extremes of brightness in the field of vision are, our tests show, very damaging to the eye.

It is naturally more difficult to get uniformity of illumination where the sources are necessarily so near, although many of the recent improvements in lighting tend toward the reduction in the magnitude of this defect. The so-called semi-indirect electric and gas lamps are better than the completely bare light sources, because part of the light is reflected from the ceiling and the rest passes through translucent glass. In this way the brightness of the light source is reduced, although even here the translucent globe, if within the range of vision, will become a source of glare. The one remedy is to hang the light so high that it will not come within the range of vision. The indirect method of lighting, in which all of the light comes to the eye only after reflection, the source usually being hidden from direct view by an opaque bowl, is at present the nearest approximation to the ideal lighting system. Although a greater light intensity at the source must

be maintained than in the other two systems, namely, the direct and the semi-indirect, on account of loss through reflection, this is more than compensated for by the reduction in fatigue and discomfort.

One of the most common and persistent causes of glare both with natural and artificial illumination, is the use of highly glazed paper in books and magazines. Its effect, even where the light source is out of the direct field of vision, is thus described by one investigator:

> Obviously a child holding a mirror flat upon the printed page of a book can see the image of a light source which is well above his head out of the normal visual field. The result of glazed paper too often used in books is somewhat analogous. Owing to the fact that the image of the light source is regularly reflected by the black letters and the white background with practically equal facility, there is a decrease in contrast between the printed matter and the background, causing difficulty in reading and also a distracting and harmful effect of the "glare spot." For these reasons glazed surfaces have been condemned by the light specialist.

It is encouraging to note that more and more of our new books are being printed on unglazed and rough surface paper. Wherever half-tone cuts and colored illustrations are used glazed surfaces are now necessary for satisfactory printing. Doubtless, a dull surface will be devised which will still take such illustrations.

The intensity of the illumination has always been

considered the really vital matter, and devices such as reflectors and drop lights for increasing the intensity at the working surface are in common use. It is now known that it is far less important to have high intensity than evenness of illumination, on account of the very rapid adaptation of the eye to different light intensities. Under proper distribution conditions, a rather wide range of variation in intensity is possible with no decrease in efficiency. The emphasis upon high intensity of illumination has been due, among other reasons, to the use of the visual acuity or keenness of vision as a test for light efficiency. This is a momentary test of how small an object can be perceived at a given distance, and in such a case the best results can be obtained with a strong light. A better and more practical measure of efficiency, certainly one approximating everyday conditions more closely, is that of the onset of fatigue and discomfort. For the former Ferree has devised a satisfactory measure and for the latter introspections must be relied upon. When these two indicators are used, it is found that for ordinary work a very strong light is not necessary. The fact that many persons believe the old type of oil lamp easier on the eyes than our present lighting systems is due largely to its low intensity, and the location of it out of the range of direct vision. Wherever high acuity of vision is demanded, as in drafting and similar fine work, high light intensity is necessary, but in all other cases much less

light is required for comfort over a long period than is generally supposed. For instance, Ferree found that the light intensity recommended in 1912 by the Illuminating Engineering Society was about double that shown to be the most efficient by the fatigue test.

While evenly distributed illumination such as is produced by daylight and by indirect artificial light properly installed gives the best results, it is worth while to consider how the system of direct lighting may be made least offensive. This will be especially valuable if it gives to the individual a means of protecting himself against lighting conditions over which he has no control. Three possibilities present themselves: First, to lower the intensity of the light at its source, thereby reducing somewhat the unevenness of the general illumination. It is evident that this remedy can be applied only within limits, and that as long as there is enough light for distinct vision, the bare light source will have all of the disadvantages previously mentioned. Second, by shading the eyes from the direct effect of the light. This is commonly done and does decrease the discomfort somewhat. It has been found from tests that if eye shades are to be used, they should preferably be opaque rather than translucent and lined with white next to the face rather than with dark material. Unfortunately, most of the eye shades that are on the market are provided with a dark under surface. Reference to the four characteristics of

vision as described at the beginning of the chapter will show that the dark lining of an eye shade will decrease the evenness of illumination and produce glare by contrast between the dark surface of the shade and the light from the lamp. Moreover, the edge of the shade, being dark against the light, will serve as an object, tending to attract the attention away from the real source of interest, and at the same time tend to produce visual accommodation for this extremely near point, with eye fatigue as a result. The translucent eye shades are usually green and are good only as they approximate the opaque, but still having the disadvantage of being dark.

The third possible correction for the defects of direct lighting consists in putting shades directly upon the light. This is generally preferable to the use of eye shades and is good to the extent that it hides the bright light source and approximates the effect produced by indirect lighting and daylight. It will always be, however, only a makeshift and less efficient than the indirect lighting systems.

Concerning the value of different color qualities in illumination little is known. In most of the experiments which have been performed visual acuity was taken as the measure of efficiency, and these show the greatest acuity with white light. The few fatigue tests which have been made indicate that white light such as comes from the ordinary tungsten lamp is more efficient than any kind of colored light. The restful effects attributed to the

carbon lamps and the oil lamps are doubtless due to their relatively low intensity, with its advantages wherever direct lighting is used. The question of color therapy, or the use of colored lights for the treatment of diseases, mental and physical, has attracted attention at various times. Quite a body of tradition has accumulated concerning the efficacy of certain colors, especially in the treatment of nervous affections. Space will not permit a discussion of the curative powers which colors are supposed to have; moreover, no scientific data concerning them is available. The use of colored spectacles, such as amber, rose and smoked glass is mainly to reduce the intensity of the light, although special properties have at various times been attributed to certain colors. Here, too, experimental data is almost entirely lacking.

Distractions.—If the average person were to be asked whether or not distractions of any sort are advantageous, his reply would most likely be that they are not, for the term distraction implies an interference or disturbance. Evidence could be adduced of the disturbing effects upon efficient work of an aching corn, an itching nose, an ill-fitting collar, a broken finger nail, the hum of conversation or the rattle of a typewriter. Still, there is the opposite view popularly put into the saying that "a dog without fleas would die," and the testimony of persons who seem either entirely unaffected or even benefited by a limited amount of distraction.

At the present time when a search is being made for causes of inefficiency, and when business offices are filled with the clicking of typewriters, when industrial plants are resounding with the noise of huge machines, and most of all when the terrific roar of the battlefields is driving men mad, the question of the real effect of distractions is worthy of careful study. Whether the distractions be great or small, the problem remains the same—namely, are distractions harmful and if so, why?

Little aid has been given thus far by experimental studies of distraction and its effects, although the tendency has been to minimize the influence of most kinds of distraotion. This conclusion has been reached by comparative measurements of the amount and quality of work done under conditions distracting and free from distraction. Now, it is a matter of common knowledge that when conditions are made more difficult an individual will usually rise to the occasion and overcome the difficulty. Experimental evidence supports this belief. One practically never exerts himself to the limit, either mentally or physically, so that there is a reserve supply of energy which may be drawn upon to overcome difficulties. We have discussed in a previous chapter the value of incentives to action, whether it be memorizing a poem or acquiring an act of skill. Now it happens that disturbances in one's environment may serve as a stimulus or incentive to greater effort in order to overcome them, and hence give

the impression of increased efficiency. Experiments recently performed have shown that if told to do his best, one will do equally well an easy and a hard task, or the same task equally well in an environment free from or filled with disturbances. For instance, Morgan found that when a person was instructed to do his best in every case, an increase of 300 per cent in the difficulty of the task produced a decrease in output of only 16.3 per cent.

It has been shown, also, that a reflex action, e. g., the knee jerk, which normally occurs when the knee is struck a light blow, will be more violent if a beam of light is allowed to fall upon the eye or a sound to strike the ear at just the proper moment. This reënforcement is called "dynamogenesis." It is found not only in reflexes but in voluntary reactions, such as that of lifting the finger when a beam of light strikes the eye. For example, if a loud sound occurs at the right moment the finger reaction to the light stimulus will be quickened. Strength, as measured upon the dynamometer is likewise subject to increase through dynamogenesis. It is to be noted, however, that the facilitation occurs only when the additional stimulus is given at exactly the right moment, otherwise a retardation will result.

The average person judges of the effects of distraction in terms of discomfort and feelings of fatigue, while the experimental measures have been in terms of the quantity or quality of the work done. What should be the ultimate measure of the effects

of distraction? The fundamental question in all activity reduces to that of energy and its conservation. From this point of view, a distracting noise that one can disregard by an added effort so as to keep up to the normal is still detrimental, because it is using additional energy and will lead to an early fatigue. One of the main evils of the direct lighting systems, as compared with the indirect, we have just said, consists in its tendency to cause distractions such as turning the eyes toward the light and accommodating for it; while inhibiting these movements means discomfort and fatigue.

Measurement of distraction effects directly in terms of energy consumption is not possible except under the most elaborate experimental conditions, but it is possible to approach the problem in another way. If overcoming distractions means using additional energy, how is this energy used? The extra work must consist either in the activity of mechanisms antagonistic to those acting as a result of the distraction, thus inhibiting a response, or in the increased activity of other mechanisms. For example, in a recent investigation Morgan found that in the case of an activity somewhat like typewriting, noises of various kinds caused almost no change in speed or accuracy of the work, but he did find markedly greater intensity of the strokes upon the keys and articulation of the letters to be written.

Both sorts of movement represent the expenditure of additional energy. These were the only

movements recorded in the experiment, so that there is a possibility that much more of the body musculature took part in resisting the noise distractions. This is not a mere assumption—resisting a distraction may be said to consist in forced attention to the task in hand. And forced attention is known to be accompanied by increased reactions of the adjusting muscles of the sense organs, by a general reaction of the voluntary muscles, producing a more or less fixed posture of the body, and by increased activity of the involuntary muscles, indicated in respiratory and circulatory changes, all of which consume bodily energy.

The practical rule would seem to be, from this survey of distraction, that where work of high quality or in large quantity is to be done, the environment should be as free as possible from distractions of all sorts. In certain industries where efficiency methods have been introduced, not only such simple distractions as lights and sounds, uncomfortable and ill-suited clothing have been eliminated, but more complex mental distractions such as fear of accident have been removed by safety appliances, fear of sickness by introduction of methods of sanitation, fear of leaving dependents unprovided for by the introduction of insurance schemes. If the reports are to be accepted, efficiency is increased by this means. The rule will apply not only to highly organized industries, but the individual may find means of eliminating from his environment many

apparently slight distractions, which in the course of weeks or months would make a considerable drain upon his energy.

Monotony.—Very closely related to the question of distractions and their elimination is that of monotony and its possible effects. Will the removal of all distractions from one's environment produce monotony, in the commonly accepted meaning of the term? The hypnotist is aided in his work by a monotonous environment, a darkened room, a rhythmically beating metronome, or a gentle stroking of the arm or forehead. A person prepares for sleep by darkening the room, closing the doors to shut out disturbing sounds, by removing restricting garments. Many times when students are placed in an environment as free as possible from distractions, such as a dark, sound-proof room, they complain of inability to do as good work as when they are in more natural surroundings. Factory operatives prefer to work in groups and seem to accomplish more in spite of the distractions which such an arrangement entails. Considerable objection has been raised against the modern efficiency methods of functionalization, in that they force workmen into a monotonous routine, a repetition, day after day, of a few simple and unvarying movements.

On the other hand there is the recognized necessity for the elimination of distractions in reading rooms and libraries, indicated by prohibition of talking, by the presence of alcoves for individual

readers, and by the use of sound deadening floor coverings. The reader can doubtless supply many other instances where simplicity of the environment is considered necessary for efficient work.

Monotony from the psychological point of view is due to the state of mind rather than to the state of the environment. The same environment may be extremely monotonous for one person and quite stimulating for another. It is less a matter of presence or absence of distractions, of uniformity in the environment, than of the presence or absence of incentive and interest. The mathematician does not find the observation of a point monotonous, because it serves as the starting point for much thinking; the geologist is interested in examining rocks, monotonously uniform according to ordinary observers; the factory inspector of ball bearings finds a sufficiently varied task in the search for lack of perfection in all its possible forms.

Consequently, the practical problem is not so much that of attempting to avoid monotony as it is to create interest in what is apparently a simple, uniform task. The proper use of incentives, as discussed in an earlier chapter, will serve to arouse interest in most persons, where it would not naturally be present, and cause monotony to disappear. We find, then, in the phenomena of monotony no argument for allowing potential distractions of the attention, of whatever sort they may be, to be present in the environment of the efficient worker.

CHAPTER VIII

WORK, FATIGUE, REST AND SLEEP

We have had occasion to speak of the importance of fatigue in connection with earlier topics. Among other things we have found that fatiguability is given as one important difference between the sexes; and that the quality of one's learning at any time depends upon the influence of fatigue; that it is more economical to divide time available for learning into a number of periods in order to avoid fatigue, rather than spend it in continuous study. And we shall find one of the most vital questions in all practical work to be how to eliminate, avoid or recover from fatigue. The answer to these questions and many others requires that we shall understand the phenomena of fatigue, both physical and mental, and especially that we shall be able to detect the real symptoms of fatigue.

Work and Fatigue.—Fatigue is usually defined as a decreased capacity for work, which may be determined by measurement of production; or it may be defined as a mass of sensations and feelings, producing a state of consciousness usually unpleas-

ant, to be measured directly by introspection alone. These two meanings of fatigue must be kept distinct, for they are not necessarily interchangeable. A person may have a very pronounced fatigue consciousness, may feel fatigued, and yet show no reduction in capacity for work, no reduced output; while on the other hand, he may feel no fatigue at all, when greatly aroused, and yet be near the point of exhaustion. Which, then, is the correct measure of fatigue—feelings, or the amount of work done per unit of time, or a combination of both feelings and work done? This question can be answered only after an examination of the facts of fatigue and its conditions.

There are two possible sources of fatigue, each of which needs a brief description:

First, fatigue may be the result of the consumption of energy-producing material as a result of activity, very much as the production of energy in the steam engine requires the burning of coal. A state of absolute fatigue would result from a total consumption of energy-producing material, after which work would be impossible until a new stock of material was provided. This kind of fatigue is demonstrated in the case of muscular activity. The energy-producing substance in the muscle is glycogen, a chemical substance manufactured in the liver and in the muscles, from material taken from the blood stream. Energy is set free when the oxygen of the blood unites with this glycogen in the

muscle. In strenuous muscular activity the glycogen is used more rapidly than it can be supplied and consequently the supply is depleted. Fatigue from lack of fuel would occur rather rapidly if it were not for the fact that the liver serves as a reserve storehouse for glycogen and throws off into the blood stream a quantity sufficient to keep the muscles supplied in ordinary muscular work. But in cases of extreme and prolonged muscular activity even this reserve of glycogen may be exhausted and complete fatigue may result.

Second, complete fatigue from exhaustion of glycogen, except under extreme conditions, does not occur because activity is stopped from another cause before that danger point is reached. The consumption of the energy-producing material leaves certain by-products, among them being carbon dioxide and lactic acid, which act as poisons to the tissues and when permitted to accumulate in sufficient quantities may clog the muscle and retard or inhibit its action. Under ordinary circumstances these waste products are eliminated about as rapidly as they are produced, but under prolonged activity they accumulate faster than they can be removed. It is the presence of these poisons which in most cases is responsible for our fatigue states rather than the actual exhaustion of the combustible material, glycogen. It is significant that these poisons do not remain in the active muscle, but are poured into the blood stream. When carried by the blood in great

quantities they may produce fatigue conditions in inactive portions of the musculature and in the body as a whole. The classical demonstration of this so-called transferred fatigue consists in transferring fatigue-poisoned blood into unfatigued animals, and fresh blood into fatigued ones, thereby producing symptoms of fatigue in the former and recovery from fatigue in the latter.

Thus far we have spoken only of muscular fatigue and its causes. Is the nervous system susceptible to fatigue in the same way and to the same extent as is the muscular mechanism? Or can nervous fatigue be separated from muscular fatigue? Fatigue of the nervous system due to the depletion of energy-producing material has been questioned by some authorities, and by all others is considered slight in amount compared to that of muscle. Histological examination of nerve tissues gives some evidence of such fatigue after prolonged work, especially in the nerve cell bodies. Recently some evidence has been adduced to indicate the presence of fatigue products also in the nerve fibers. It is reasonable to suppose that there would be a consumption of energy, even in nervous activity, although the amount may be small, and the rate of repair rather rapid. If this be true, there would be the possibility of nervous exhaustion as well as muscular exhaustion in extreme cases. Such fatigue is considered by Crile to be the basis of surgical shock, resulting from the violent stimulation of parts of

the central nervous system in an individual who is under an anesthetic. But nerve fatigue as the result of the transference of fatigue products from the muscles by way of the blood to the nerve tissues, is quite possible, and is generally recognized as the cause of the mental lassitude following upon severe and long continued muscular work. Since fatigue results from both of the above mentioned causes, namely, the reduction of energy-producing material and the accumulation of poisons, it is not possible to separate nerve fatigue from muscle fatigue, except under experimental conditions, for the one would involve the other.

Granting the validity of muscle and nerve fatigue, one question still remains, namely: Is there such condition as mental fatigue? Needless to say, this problem is an involved one, since nervous activity always parallels mental activity and a certain amount of muscular activity almost always parallels it. For instance, "mental multiplication," or the multiplication of numbers without the aid of visual or written aids, comes near to being purely mental work; and yet the extreme state of attention necessary is accompanied by sense organ adjustment and tension of much of the bodily musculature. Consequently, mental fatigue may be attributed to loss of energy-producing material and to the accumulation of poisonous by-products of *nerve* and *muscle* activity. Since mental action is correlated with nerve action, and fatigue of this mechanism is

slight compared with that of the muscular mechanism, with recuperation probably very rapid, the reality of mental fatigue has sometimes been questioned. Under ordinary working conditions, such as those of the child in school or the student at his desk, it is not the onset of fatigue which affects efficiency so much as lack of interest and incentive. Proof of this lies in the fact that where fatigue is apparently present, an increased incentive will alone suffice to bring the output of work up to normal. But that fatigue in the sense of reduced capacity for work does follow intense and long continued mental activity, is indicated by a recent report of an experiment in mental multiplication. In this case the same procedure was followed as is commonly used in such tests, and complete inability to work resulted after many hours.

To ask whether mental fatigue, independent of nerve or muscle fatigue, is possible, appears to be a purely theoretical question, since so far as we are aware it is impossible to have mental activity independent of nerve and muscle activity.

Since fatigue of whatever sort is a real physiological phenomenon, and extreme fatigue states are dangerous, it is important to know, first: What are reliable symptoms of genuine fatigue? and second: How may fatigue be best and most quickly overcome? The second question will be discussed under Rest and Sleep. What then are the symptoms of fatigue and how shall fatigue be measured? The

most direct means of measuring fatigue would be to measure the metabolic changes of the mechanism in action in terms of energy-producing material consumed and by-products eliminated. Such a method, however, is impossible except under the most elaborate experimental conditions, so more indirect criteria must be sought in most cases. The following criteria of fatigue have been suggested:

1.—Feeling tired, loss of interest, inability to fix the attention, headache and many other conscious states have been suggested as valid signs of fatigue. Certainly, they are the symptoms by which most persons regulate their activity, and they constitute fatigue according to the second of the definitions stated at the beginning of this chapter. These conscious states are by no means infallible signs of decreased capacity for work. For instance, feelings of discomfort and distaste for work may be present and have a tendency to inhibit action when objective measures of actual production show the individual to be at maximum efficiency. One has only to recall the feelings akin to fatigue which he often experiences in beginning a hard task after a long period of rest. And then, too, these conscious symptoms may be absent, in states of great excitement or where unusual incentives act as a driving force, although the physiological changes may be approaching their limit. For most persons feelings of fatigue would be very inefficient indicators of capacity to work.

2.—A number of conditions resulting from decreased sensitivity of the nervous system, have been suggested as indicators of fatigue, such as sense organ sensitivity, the change in the two-point threshold of the skin (the distance between two points touching the skin just great enough that two points may be felt), speed of reaction and muscular strength measured by the dynamometer. But experimental tests show that there is no direct relation between these indicators and the actual efficiency measured by the capacity for work. The difficulty probably is that these tasks involve so many other conditions that the effects of fatigue can not show themselves consistently. For instance, the two-point threshold as a measure of fatigue is unsatisfactory because fluctuations of attention occurring during the course of a few minutes, are likely to cause as great changes in the threshold as a day's work in the school room. The degree of sensitivity of all of the sense organs depends so much upon fluctuations of attention that it seems poorly adapted for measurement of the more slowly developing fatigue.

3.—For practical purposes the proper measure would naturally seem to be the quality and quantity of work produced in a given unit of time. If a man is shoveling dirt and the amount shoveled per hour at the end of the day is only two-thirds of that shoveled in the early part of the day, he has fatigued about one-third of his capacity. But one's actual

output is known to depend on many other factors, besides actual capacity to work, among them being incentive and interest. It has been found that a laborer paid by the day gradually decreases his output during the course of the day, while the same one paid by the piece or the task may even increase his output toward the close of the working hours.

4.—What, then, shall be taken as a measure of fatigue if these criteria fail? It has been suggested that each individual must work out for himself and from his own experience, what his limits of safety are, and the rule has been offered that the safe limit for fatigue is that degree of it which can be recovered from in one normal night's sleep. Such criteria each one probably does work out for himself, but the great shortcoming is that many persons who are never forced to do real intensive work do not discover their maximum efficiency, and consequently live on a much more inefficient plane than necessary. The rule would apply only where a person is trying to find his limit of normal fatigue.

Measurement in terms of output or production, in which each person learns to interpret certain conscious signs as indicative of his safe limit, is, then, about the only rule that can be laid down, in our present inability to measure the physiological changes without difficult and elaborate procedure. In industrial work where certain uniform demands are made, the personal differences must be taken into account, e. g., that some persons tire quickly,

others slowly, that some work at high pressure for a short time, others work more slowly and steadily, and a standard must be set which will approximate a fair maximum for the majority of people working at a given task. The establishment of fatigue standards for various kinds of work is one of the most important problems which efficiency engineers are attempting to solve.

Rest and Sleep.—How may fatigue be best and most quickly overcome? Theoretically our problem is to find the best means of eliminating fatigue poisons and supplying energy-producing material. Fatigue is sometimes described as unnecessary and necessary, the former being the result of useless and wrong movements in attaining an end, the latter being the result of necessary movements. This discussion deals only with the latter sort of fatigue, since the elimination of wrong and useless movements was discussed in Chapter IV. The metabolic processes of waste and repair, or fatigue and recovery are continually occurring within the body, but our discussion will be limited to cumulative fatigue, that which is not compensated for from moment to moment. Numerous questions arise concerning recovery from fatigue, and the conditions of rest. A few of the most important of these follow:

1.—Is change of occupation a rest, or must there be complete inactivity?

2.—What should be the relation between work periods and rest periods?

3.—Does sleep provide complete rest and the only complete rest?

4.—How much sleep is required and how shall one know his requirements?

5.—Does recuperation take place equally throughout the whole sleep period, or are some portions of it more valuable than others?

6.—What is the source of the energy-producing material? What is the importance of such matters as food supply, character of the air breathed, etc., on the general bodily condition?

1.—There are two answers possible to the question as to whether a change of occupation is a rest. If fatigue is due to the *local* exhaustion of energy-producing material or is due to the *local* accumulation of fatigue poisons, then fatigue itself can be considered a local condition, and a change of occupation requiring the use of other mechanisms than those affected by the previous activity, would constitute a rest. If, on the other hand, activity causes a general reduction in the supply of material by drawing from the blood stream the necessary constituents, and general poisoning by throwing into the blood stream the poisonous by-products of activity, which are then circulated through the body, change from one occupation to another requiring equal activity would not constitute a rest. Practically every case of activity of a limited sort pro-

duces both a local and a less pronounced general transferred fatigue. The supply of material does not immediately follow the demand, hence other parts than those which have been acting may be relatively fresher. But the total amount of fatigue is not reduced by the shift of activity.

When the second task is easier than the first, that is, requires the consumption of less energy, then it will give rest or relief when compared with the effects of a continuation of the original work. It would be better to say that there is in such a case a relative reduction in the amount of energy consumed. Usually the changes of occupation which we make when tired are toward the easier and more pleasurable tasks. One's own inclination seems to take care of that, so that the common impression is likely to be that changes of occupation are a distinct rest.

2.—The close relation between the length of a work period and the required rest period is evident. The most economical work period must be determined in relation to the onset of fatigue in every kind of work. This relation between work and fatigue has received considerable attention in connection with school work and hours of study and has lately been studied in connection with industrial efficiency and the regulation of the length of the working day. The questions, especially those concerning the optimum length of the working day, have already been discussed, but it may be said

here that the tendency toward shorter working days is growing and that in the majority of cases there is an increase in total work done rather than a decrease such as might be expected. It is simply a demonstration of the fact that a certain balance between work and rest can be obtained which will give the maximum efficiency. This balance must be measured for each different task and kind of working condition, but certain general principles may be pointed out which will hold for all conditions. Fatigue, in itself, need not be harmful, so that the first signs of fatigue do not indicate the end of the optimum working period. Theoretically, the work period should end where the reduction due to the onset of fatigue becomes enough greater than the improvement due to practice or adaptation, that further production costs too much in energy for the results obtained. It is a well known characteristic of the work curve (a graphic representation of work done), that it first rises, indicating that the efficiency increases gradually for a time; a level is then reached which may be maintained for a certain period; this is followed by a decline in the curve, which indicates that the efficiency is being reduced. The initial rise in the curve, is usually called the "warming up period," and is familiar in most curves of mental and muscular work. Just as it is inefficient to continue work after the curve has descended beyond a certain point, so is it inefficient to stop work too soon, for in that case one does not

get the full advantage of the initial warming up, and needs to get adapted anew each time the task is begun.

The length of the rest period required depends upon the nature of the work and upon the length of the work period. The rests should be just long enough to permit recovery from fatigue without losing further time or momentum. Such a schedule has been prepared for the work of folding handkerchiefs. Each hour of the working day is divided into six minute periods, and for each five minutes of work there is one minute of rest. Although one-sixth of the day is spent in rest, the more intense work possible during the other five-sixths results in about three times as much work from each employee. Schedules for other sorts of work have been prepared with equal increase in efficiency. A five minute rest period for each hour of work is a good schedule for mental work.

3.—Does sleep provide complete rest? If a change of occupation does not provide complete rest, when does one rest? Rest must be looked upon as a state which we can only approximate, but never obtain, since our minds are active during all of our waking hours, and many of our muscles are active, even if in no other way than in supporting part of the body weight. Consequently, all rest might be conceived as a change of occupation in which the second activity approaches more or less a state of complete inactivity. Even during sleep there is not

perfect rest, as the mind may be active in dreams and the body may move. But it must be granted that normal sleep approaches more nearly the ideal rest conditions than the waking state.

Practically all of the physiological theories of sleep attribute its onset to either a diminution of energy-producing material or an accumulation of fatigue by-products. These conditions in one way or another, differing according to different theories, produce the state of unconsciousness called sleep. Although there is much doubt about just what sort of circulatory changes take place in the sleep state, evidence is not lacking to show an increased rate of repair. For instance, the most recent work upon brain circulation during sleep shows that, contrary to the prevailing belief, the amount of blood in the cerebral vessels increases during sleep. J. F. Shepard, who performed these experiments, says, "If any special utility is to be assigned to this fact (increased blood supply to the brain during sleep), it may be that the effective building up of energy-giving substance in the brain requires greater circulation than is demanded by other parts."

4.—How much sleep is required and how shall one know his requirements? One hears occasionally of persons who need either no sleep at all or else very little. The majority of such persons substitute a waking state of complete relaxation or rest of both body and mind for ordinary sleep. If one can do this, there is no reason why sleep strictly speaking

should not be dispensed with. It makes comparatively little difference whether one undergoes the rebuilding process in sleep or in a state of relaxation, the fundamental need is a state of relative inactivity.

Besides individuals who substitute relaxed states for sleep, there are a few other remarkable persons who seem to require neither. Thus Thomas A. Edison is quoted as calling sleep an absurdity, a bad habit which ought to be overcome, and must be overcome by the human race. To support this view, an experiment by Mr. Edison and eight of his men is cited, in which the group worked from 145 to 150 hours a week for five weeks. That is equivalent to more than twenty-one hours a day. It is said that every man gained weight during the five weeks and felt perfectly well. Mr. Edison believes that the average man who sleeps seven or eight hours a day suffers from lassitude, while if he slept only four or five hours he would feel clear as a bell, and always wake up full of energy. There is always danger, however, in setting up standards attained by a few unusual individuals to be followed by people as a whole.

If sleep results from fatigue and constitutes a process of repair, then, obviously, the amount of sleep must depend on the amount of cumulative fatigue. This not only differs for various kinds of work, physical and mental, but differs widely with the individual. Some persons seem to preserve the

balance between waste and repair more perfectly than others, hence have less cumulative fatigue and need less sleep. If the rate of waste and repair for a given type of activity can be equalized, the knowledge of the means would be of immense value. An approximation to this balance is obtained by the adoption of rest periods in the midst of work. There is no doubt that the proper regulation of work periods and rest periods will do much toward the elimination of cumulative fatigue.

The exact amount of sleep required will always remain a problem to be solved for each individual case. It must be sufficient to keep him in a state of physical and mental efficiency, this to be determined by the amount and quality of work done over a long period of time. In no case should the tests be limited to periods as short as a week or two weeks, for cumulative effects might be harmful and not show themselves in this time.

5.—The question whether recuperation takes place uniformly throughout the whole period of sleep is one that can be answered only indirectly. Many measurements have been made of the depth of sleep and there is general agreement that the deepest sleep occurs during the first hour and then gradually decreases during the remaining hours. But whether recuperation occurs more rapidly in the period of deepest sleep or not is uncertain. The belief that only the deepest sleep is beneficial has been current at different times, and many ingenious schemes have

been used to prevent sleep after the deepest stage has passed. One of these consisted in sleeping upon a very narrow board, so that as soon as any movement, indicative of light sleep, occurred, the sleeper would fall off of the board and be wakened. Shepard, quoted above, says that sleep becomes lighter probably because of the elimination of a quantity of waste products. However, the slight benefit obtained from sleep broken into short periods has suggested that the real anabolic processes do not become very effective until after this period of deep sleep has passed.

6.—The energy-producing material for muscle and nerve, as well as the material needed for structural growth, is supplied from food and air,—the glycogen from the food and the oxygen from the air. Consequently, the quantity and the quality of the food consumed and the air breathed are factors not to be neglected in the production of efficiency. The latter factor has been discussed in an earlier chapter in connection with the broader question of the influence of climate and atmospheric conditions upon efficiency.

The efficiency value of foods for the upbuilding of the body has received much attention of late, especially on account of economic pressure and the high cost of living. The evaluation of foods of all kinds as body builders has been taken up seriously by the Federal Department of Agriculture, and valuable

bulletins concerning their findings may be had for the asking.

Mr. Edison, who is said to require little sleep, also eats comparatively little food. He believes in a plain workingman's diet, and that the greatest economic gain for the world lies in the prevention of overeating.

> On the average, men would get on better if they reduced their food consumption by two-thirds. They do the work of three horse-power engines and consume the fuel which should operate fifty horse-power engines. . . . Any man engaged at hard physical labor . . . could get on perfectly well with eight or ten ounces to a meal, although he might find achievement of the habit difficult.

The above may be considered as an extreme view, but there is much truth in it. The ideas recently expressed in an article in the *Scientific Monthly* by a member of the United States Department of Agriculture may be taken as more conservative and more generally applicable. Much of what follows is taken from this source. People may be divided into three groups on the basis of their eating: First, there is the extreme in which palatability or pleasure in eating alone regulates the diet in quality and quantity. This group represents the majority of people. Second, there is the opposite extreme in which all of the fads and fantastic statements about diet are heeded. And there have been many of these fads in recent years. One's common sense can usually be relied on

to warn him that if such doctrines were true and important, the race could hardly have survived its dietary indiscretions. Fortunately, between these extremes, there is a constantly increasing third group including those people who are learning the fundamental principles of dietetics. Perhaps the most fundamental of all of these principles is that food "must supply a great variety of chemical substances combined in different ways for the structural needs of the body, and also must supply it with energy-yielding substances with which it may perform external and internal work. It seems apparent that a varied diet, reasonably generous in amount, is more likely to meet the body needs than one restricted or unvarying in its make-up or scant in quantity. The more knowledge and judgment used in its selection, the better the diet is likely to be."

The kind of food, the amount taken at a meal and the number of meals per day are largely a matter of custom. But fortunately the number of meals per day and the relative size of them does not greatly influence the total amount of food consumed per day, "for the man who goes without his breakfast is very likely to make up for it at dinner or supper, while the man who eats an early breakfast and then a second breakfast will be likely to take a moderate lunch or a light dinner."

Space will not permit a discussion of the value of specific foods in terms of energy units, and their proper combination into menus suitable for different

individuals. Obviously, the food requirements differ with difference in size, age and occupation. Tables of food requirements have been computed for "a man in the period of full vigor, weighing 150 pounds and engaged in moderate to active muscular work." Means of computing the needs for those varying from this standard have also been worked out. Such facts in convenient form are available elsewhere.

Certain matters of broad application may be mentioned. Foods may be grouped roughly into five classes:

(1) Flesh foods, including milk, cheese, eggs and certain meat substitutes such as nuts, beans, peas, etc. (2) Starchy foods. (3) Fat foods. (4) Watery fruits and vegetables. (5) Sweets. And it may be taken as a general rule that each one of these classes of food should be represented, if not at every meal, at least once a day, and that if an excessive number of food materials from any one group are used in the course of a day the result is likely to be unsatisfactory from the standpoint of rational dietetics or of taste.

Finally, meals constructed upon the above broad basis may be one of two types, the "restaurant" type or the "family" type. In the first, the principal dish is a meat order, supported by potatoes, a green vegetable, bread and butter and a dessert. In the second, the meat is relatively less important, with a much larger quantity and variety of vegetables, bread, butter and a dessert.

If we follow the rapidly gaining theory that foods like meat, which yield an acid residue when assimilated, should be accompanied by a generous amount of foods like vegetables and fruits, which yield a distinctly alkaline residue when assimilated, the wisdom of the so-called household type of meal is apparent. We shall find also, if we consider its chemical composition and energy value, that it is more likely than the other type to supply in reasonable proportion the necessary building and repair material and the energy-yielding substances required.

We may take it as a safe guide that our food should be of good quality, varied in character, with meats well balanced by vegetables and fruits, ample in quantity, the exact amount depending on the nature of the individual's activities. Whether these conditions are fulfilled may be measured by the state of the health, maintenance of a standard weight, and a standard efficiency measured in terms of productivity.

In any consideration of food values it is well to remember that the important fact is not how much food and what kind is consumed, but what proportion of it is actually transformed into tissue and fuel within the body. This assimilation of food for body needs depends most directly upon the proper functioning of the digestive mechanism. Recent studies, moreover, have shown that the state of mind has much to do with the proper digestion and assimilation of food. Everyone knows that great fear will cause the tongue to cleave to the roof of

the mouth from inhibition of the flow of saliva, and that the mere sight of a lemon will cause a copious flow of saliva. Not only this, but the other digestive juices are affected in the same way. Experiments upon man and animals have further shown that the rhythmic movements of the stomach and intestines which normally occur during digestion and are a necessary part of the process, may be completely inhibited as a result of emotional disturbances. Whether food shall be made available for body needs depends, then, among other factors, upon whether we are cheerful or sad, fearful, angry or calm, tired or rested. It behooves us for purely economical reasons to make the most use of the mental control over digestion. Variety in the preparation of foods, with the use of sauces and flavors, esthetic effects in its presentation through clean linen, pretty dishes, decorative devices and every other appeal to the appetite is in the end an economy. Likewise, sociability, music, pleasant surroundings, freedom from fatigue and worry and other means of producing good cheer are aids to digestion not to be overlooked.

CHAPTER IX

DRUGS AND STIMULANTS

The real effects of drugs and stimulants upon human activity must be determined from the most careful and scientific procedure as opposed to the unchecked opinion and prejudice which are responsible for the common popular impressions. There is no field of psychological investigation more difficult and involved than this one of the effects of drugs and stimulants. The difficulties of experimental procedure are largely due to the suggestibility of people who have a knowledge of the effects to be expected. Much of the experimental work has failed to eliminate the possibility of suggestion and the results are questionable on that account. A further source of error in many tests has been the lack of control subjects, or persons who are treated in every way identical with the others, except that the drug or stimulant in question is not administered to them. Control groups serve as a check against interpreting as drug effects results which are due to other factors, affecting both groups alike. The first difficulty, that of suggestibility, can be avoided only by preventing persons from knowing what

drugs they are taking, and when they are taking them. The drugs must be disguised, usually by having them placed in a neutral substance of some kind, which may be given regularly, sometimes containing the drug and sometimes not. In some cases the fulfillment of these conditions is extremely difficult and in others practically impossible.

There is a further serious difficulty in this type of investigation, which, however, is not limited to drug experiments exclusively, namely, the measurement of the effect. Shall it be measured in terms of work done, an objective measure, or shall it be measured in terms of feelings, a purely subjective measure. Both indicators seem partially inadequate in this work. The effects of a drug are likely to consist in an increased difficulty of a given task, a greater inertia which must be overcome. But it can be overcome by increased effort, hence the objective measure may remain unchanged. In such a case it might appear that the feelings of effort would be a more accurate measure than the objective record, except for the known unreliability of the subjective criteria of efficiency. Consequently, a third measure has been suggested, a direct measure of the energy consumed in work under drug conditions as compared with normal conditions. The measurement of energy consumption is such an elaborate and technical task that it is practically excluded from the majority of the experimental tests. Most of the experiments upon which our discussions are based

have used objective records of one kind or another to determine drug effects, emphasis being placed where possible upon the selection of forms of behavior for measurement which are partially independent of voluntary control.

One further difficulty may be mentioned, viz., that the experiments devised for testing the effects of drugs and stimulants are quite short in duration compared with the long periods over which they may be used in actual practice. Consequently, conclusions from such experiments must be limited to conditions tested and not made to cover cases of long continued use. This error is not peculiar to psychological tests alone. The same criticism, for instance, may be lodged against the tests of the physiological effects of benzoate of soda, which established it as harmless when taken in extremely small quantities. Has the possibility of cumulative effect from long continued use been sufficiently taken into account?

Our discussion will cover the effect of only the more common drugs and stimulants, such as are real factors in the problem of personal efficiency. They will be considered in the following four groups: (1) Tobacco, especially when smoked. (2) Alcohol, in the various forms in which it is commonly taken. (3) Caffeine, which is the drug appearing in coffee, tea and some soda fountain drinks. (4) Such less common drugs as cocaine, strychnine, morphine, etc.

Tobacco.—Statistical studies of the influence of

tobacco smoking, such as the number of inmates of penal institutions who use tobacco, and the influence of tobacco on growth as determined by the relative number of tall and short persons who used tobacco during the growth period, are complex to say the least. In this regard they remind one of the figures representing the effects of weather conditions upon efficiency. The humorous remark that a "drop of nicotine on the tongue of a cat will kill the strongest man," illustrates fairly well the character of the data usually brought to bear on the question.

From the experimental point of view the investigation of tobacco and especially smoking, the most common form in which it is used, is subject to all of the difficulties mentioned above as peculiar to drug problems. Especially important and almost impossible to eliminate is the factor of suggestion. At least it never has been eliminated in any of the studies thus far made. And in all cases the experiments fall short of actual conditions in that they cover relatively brief periods of time. Most of the experiments report the effects following immediately after smoking, the indulgence being limited usually to one cigar, cigarette or the like.

Tobacco is commonly said to reduce efficiency by introducing a poison into the system, and this poison is generally believed to be nicotine. Consequently, nicotine has been given in experimental doses and the effects produced are interpreted as indicative of the effects of tobacco smoking. The proportion

of nicotine carried in smoke ranges, according to different authorities, from seven to seventy per cent of that contained in the tobacco. As a matter of fact recent chemical analyses tend to show that it is exceptional to find any nicotine at all in tobacco smoke. (It does occur in small quantities in the smoke of rapidly burning cigarettes.) The nicotine in the burning is decomposed into pyradine and other substances. It may seem to make little difference whether the toxic factor be called nicotine or pyradine, except for the fact that pyradine is only about one-twentieth as poisonous as nicotine. The physiological effects of nicotine introduced into the body through smoking are said to be moderate constriction of blood vessels, rise in blood pressure during the smoking period with a rapid fall immediately afterward, primary slowing of the heart action followed by a secondary quickening and increase in the rate and amplitude of breathing.

Numerous statistical studies of the effects of tobacco smoking have been reported and the following cases may be taken as representative of them. Meylan examined the scholarship records of over two hundred Columbia University students, of whom 115 were smokers and 108 were non-smokers. The academic records were as follows:

	Average Entrance Marks	Average 1st 2 yrs.	Failures 1st 2 yrs.
115 smokers	89	62	10%
108 non-smokers	91	69	4%

Taylor studied the average grades of 500 boys of a private school as compared with their tobacco habits and presents the following statistics:

Age of students	12	13	14	15	16	17
Per cent of smokers	15	20	38	29	57	71
Grades of smokers	73	75	73	75	75	68
Grades of non-smokers	83	90	89	84	87	85

Clark found that of smokers in Clark College, 18.3 per cent won academic honors, while of non-smokers, 68.5 per cent won academic honors.

These statistical results are not unequivocal, for there are fundamental sources of error that cannot be eliminated. Can it be said that smoking is such a handicap to performance as the figures suggest, or that smoking is an indicator or symptom of intellectual inferiority? The reader may choose between these two alternatives for the present, or accept neither.

Experimental studies of this problem are not lacking, although there are few that satisfy the fundamental requirements of experimental technique. Most of the experiments concerning the influence of tobacco upon physical efficiency have been made with the ergograph, measuring the physical endurance of a limited number of muscles, in terms of amount of work done in a series of muscular contractions; or by the dynamometer, measuring the strength or force of single muscular contractions. M. Lombard found that a single cigar of moderate

strength reduced muscular strength from 10.4 to 2.1 kilogrammeters (a unit of measure, meaning the work done in lifting a weight of one kilogram to the height of one meter) or a decrease in efficiency of 80 per cent. This depression began to disappear soon after smoking ceased but complete recovery required more than one hour. The same investigator found that muscular contractions produced by electrical stimulation instead of the individual's volition, were not reduced, and consequently located the depressing effect somewhere in the central nervous system. Feré found cigarette smoking to induce a state of depression, after an interval of fifteen minutes, showing itself in reduced capacity for work.

All investigators have not found such striking results, among them being Rivers, Vaughan and Harley and Hough. Their reports show a change after smoking no greater than that which occurs normally at different periods of a day, while one of them seems to find a slower fatigue rate after smoking than occurs normally. Rivers' explanation of the slight decrease in efficiency found in his own tests is interesting. The circumstances surrounding the act of smoking are stimulating, that is, the sensory stimulation from the odor and the taste of tobacco are in themselves causes of increased efficiency. Consequently, the small decrease in efficiency from smoking is significant when compared with the expected increase from the sensory stimulation. This

serves as an illustration of the complicated character of the whole experimental problem, and the necessity for the most careful interpretation of data. The prohibition of smoking in all persons who are undergoing training for speed, strength and endurance tests, is a practical application of the belief in the deleterious effects of tobacco on physical efficiency.

The influence of tobacco on mental efficiency has been the subject of few important researches, and none has succeeded in eliminating all sources of error. It is in this type of work that suggestion plays its largest part and where the necessity for control subjects is greatest. This is especially true because the mental tests of efficiency are almost all subject to improvement from practice and often a great improvement may be noted from one repetition of the test to another. In the absence of controls, improvement from practice might be wrongly attributed to the stimulating influence of tobacco, or might hide a real decrease in mental efficiency.

Bush tested the mental effects of smoking upon 17 students, 15 of whom were regular smokers and 2 were non-smokers. One of the two non-smokers served as a control subject and the other smoked only cubeb cigarettes. Six well known mental tests were used, including speed of perception, free association, controlled association, memory, imagery, and calculation (addition and subtraction). The tests were first given, then the subjects were allowed to smoke quietly for fifteen minutes, after which

the tests were repeated. The records for the group of tobacco smokers, non-smoker and the cubeb smoker are given in the following table. The figures represent the difference between the tests before and after smoking in terms of the per cent of efficiency in the tests before smoking. Minus signs always indicate a decrease in efficiency after smoking, and plus signs indicate an increase in efficiency.

MENTAL EFFECTS OF TOBACCO SMOKING

Tests	Smoke Group		Control
	Tobacco (15 subjects)	Non-Tobacco (1 subject)	(1 subject)
Speed of Perception ...	—17.1	— 6.8	+ 3.4
Free Association	— 8.7	—20.5	+ 0.2
Controlled Association ..	— 8.0	—16.3	+ 1.6
(3 tests)	—14.1	+ 5.5	+ 1.0
	—12.4	+ 1.9	+ 5.4
Memory—Visual	— 2.9	0.0	0.0
Auditory	— 4.3	+ 1.4	— 4.9
Imagery	—22.2	—14.3	+18.3
Calculation—Addition ..	— 9.4	+ 9.4	+ 1.2
Subtraction	— 6.7	— 0.8	+ 1.0
Average Ability	—10.6	— 4.2	+ 2.7

The results of the experiment are summarized by the experimenter about as follows:

1.—Smoking tobacco produces an average loss of mental efficiency of 10.6 per cent, while smoking material with no tobacco content whatever reduces efficiency 4.2 per cent. In the same tests the non-

smoker gained 2.7 per cent in efficiency. The loss from smoking supposedly harmless substances like cubebs is interesting.

2.—The greatest actual loss was in the field of imagery, namely 22 per cent. The test measured the speed with which images appeared when certain stimulus words were presented.

3.—Taken together, imagery, perception and association represented the greatest loss.

4.—Nicotine was present in all of the tobaccos used, but was not found in any of the smoke, except some of the cigarette smoke. Pyradine was found in all tobacco smoke and is the toxic factor.

5.—The greatest loss of efficiency came from cigarette smoke.

6.—Tobaccos differ in their influence upon mental efficiency, as follows: The least effect comes from cheap tobacco such as is retailed in 5 and 10 cent tins and bags; the greatest effect comes from cigarette tobacco; then follow Turkish tobacco and Havana tobacco.

The figures are strikingly large in most of the tests, so that after one makes allowance for possible disturbing factors not eliminated from the experiment, and for the small number of subjects, there is still left an indication of loss of efficiency both physical and mental from the effects of tobacco smoking. There is certainly no sufficient evidence of an increase in efficiency. As a means of enjoyment and bodily comfort it has no claims over other

forms of recreation, so that from the point of view of efficiency its use cannot be recommended.

Alcohol.—No one question has been the subject of more controversy over a long period of years than that of the effects of alcohol in small doses upon the human body. The numerous experiments and statistical studies have produced conflicting results, due in part at least to the inherent sources of error. Especially important is the factor of suggestion or expectation. Most persons have rather firmly fixed notions concerning the effects of alcoholic drinks, and investigators have often been influenced by their preconceived opinions either as opponents or supporters of the use of alcoholics.

No description of the early studies of alcohol will be given, because failure to standardize procedure and eliminate errors has resulted in a great variety of conflicting conclusions. Rivers was the first investigator to disguise properly the alcohol in a mixture so that it could not be detected by the person taking it, and thus largely eliminated the influence of suggestion. He found practically no effect upon muscular work from taking alcohol in doses ranging in size from 5 to 10 cubic centimeters. Effects previously found by others from such small doses he attributes to the sensory stimulation and the expectation of stimulating effects. Even doses as large as 40 cubic centimeters did not produce entirely consistent results in all cases. Sometimes there would be an increase and sometimes a decrease in total

work done. Wherever an effect was noted, however, it consisted in a change in endurance or duration of the work rather than in the quantity of work done per unit of time. (Measured by the total number of muscular contractions on the ergograph, rather than by the extent of the single contractions.)

Dodge and Benedict, working in the Nutrition Laboratory of the Carnegie Institute, found that instead of alcohol being a general stimulant as is commonly supposed, it is really a depressant. In only one case, namely, the pulse rate, did they find an acceleration; but even this was not an absolute increase in rate and represented only the absence of the gradual decrease in pulse rate in the course of moderate mental and physical work. In the case of simple reflex and sensory processes, this depression expressed in per cent is as follows:

Increase of latent time of the knee jerk	10	per cent
Decrease in thickening of the quadriceps muscle	46	"
Protective eyelid reflex, latent time increased	7	"
Extent of eyelid movement decreased	19	"
Eye reactions, latent time increased	5	"
Speed of eye movements decreased	11	"
Sensitivity to electric stimulation decreased.	14	"
Speed of finger movements (tapping) decreased	9	"

Evidence concerning the influence of long continued use of alcohol is not experimental in char-

acter, but consists in reports of military campaigns and the like, in which the whole problem is extremely complicated, so much so that the inferences concerning endurance under alcohol are of little significance. The conclusions that have been reached are that alcohol decreases endurance and increases susceptibility to fatigue.

Pathological evidence of the effects of alcohol are more definite, although here extreme cases are usually cited. Examination of the tissues of confirmed drunkards after death shows pathological changes in stomach, liver, heart and especially in the nervous system,—findings which lead to the classification of alcohol as a tissue poison when its use is immoderate and continued for long periods.

Concerning the influence of alcohol on mental efficiency, popular opinion must be clearly distinguished from the results of scientific experiment. Alcohol in small doses is commonly supposed to increase mental activity, and to produce a feeling of general well-being, effects which quickly disappear when larger doses are taken. Under careful experimental conditions, Dodge and Benedict found that memory and association were only slightly affected and in the direction of a decrease in efficiency. Other experiments upon mental multiplication of four-place numbers and upon typewriting show little or no effect from doses of alcohol varying in size from 5 to 40 cubic centimeters, either in quantity of work done or in its quality. One other research on atten-

tion as measured by the ability to hit a moving target, indicated that after a dose of 15 cubic centimeters of alcohol one person was not at all affected while the efficiency of the other was slightly reduced.

After reviewing all of the work upon the mental and motor effects of alcohol, Rivers concludes:

> In the case of muscular work, we have seen that there is definite evidence that small doses, varying from 5 to 20 cc. of absolute alcohol have no effect on the amount or nature of the work performed with the ergograph, either immediately or within several hours of their administration, the results previously obtained by other workers being almost certainly due to defects of experimental method. With a larger dose of 40 cc., there was evidence in one case at least of an increase in the amount of work under the influence of the substance; but the increase was uncertain and inconstant, and the possibility cannot be excluded that it was due to disturbing factors. . . . In the case of mental work, the available evidence points to a decrease in the amount of work under the influence of alcohol when there is an effect at all; but there are very great individual differences, even the large dose of 100 cc. failing to show any effect in some persons.

One further fact in regard to effects of alcohol may be mentioned, namely, the relation between alcoholism in the parents and the mentality of offspring. Statistics show that the percentage of feeble-minded persons in the families of alcoholics is much higher than in the families of non-alcoholics—according to Goddard sometimes 35 per cent higher. Hence, we might conclude that alcoholism almost

doubles the number of feeble-minded. But the case is not perfectly clear, for the alcoholism itself may be the result of feeble-mindedness in the parent, and in that case the feeble-mindedness would be transmitted directly to the children. The conclusion drawn by Goddard is significant:

> Everything seems to indicate that alcoholism itself is only a symptom, that it for the most part occurs in families where there is some form of neurotic taint, especially feeble-mindedness. The percentage of our alcoholics that are also feeble-minded is very great. Indeed, one may say without fear of dispute, that more people are alcoholic because they are feeble-minded than vice versa.

A new sort of investigation has been undertaken recently to determine the influence of alcohol on mental processes, and it promises valuable results. Tests are being made of the effects of alcohol on the intelligence of animals, as indicated by their ability to learn to find their way out of a maze. It has been reported that "rats fed on alcohol average a longer time in the maze and make more errors, both at the beginning and during the latter part of the training period than normal rats." Another investigator finds that a dose of alcohol given to a rat immediately after a learning period will nullify the effects of the learning. The value of such work lies in the amount of control over the subjects, and the simplicity of the conditions of the experiment.

Practical conclusions are not difficult to draw in

the case of alcohol and efficiency. Alcohol may possibly be taken in small quantities with benefit by the aged and certain types of invalids, where it may serve as a food. But over against this is the evidence that it is not a stimulant to increased efficiency for normals, but rather a depressant. In addition, alcohol belongs to the class of habit-forming substances, against indulgence in which the body offers no check, such as is present in the case of overeating. Thus there is great likelihood of indulgence until the body tissues are injured. There is no doubt of the ill effects of the excessive use of alcohol. Large industries and railroads are beginning to recognize the danger from its use and have made abstinence a necessary qualification for employment. The decrease in the use of alcohol as a medicine by physicians is evidence that even in this field it is not indispensable.

Caffeine-containing Substances.—Caffeine as the active principle of many of the common beverages, such as coffee, tea and soda fountain drinks, has been the subject of many investigations. Since it is so commonly used by persons who shun any other stimulating drinks, it is important that its real effect should be known. The popular impression is that it acts as a stimulus to both muscular and mental work, especially the latter. There is much evidence that coffee and tea and other substances containing caffeine should be called habit-forming drinks. The person who cannot be deprived of his strong coffee

or tea without getting a headache, or at least being incapacitated for work, is a common spectacle. And an equally familiar case is that of the person who is kept awake all night by an after-dinner cup of coffee, or the student who drinks a cup of coffee to enable him to continue his studies beyond the hours when he usually retires. Are these popular notions supported by experimental work?

As in the case of the other drugs studied, most of the early work has produced conflicting and inconclusive results. With the exception of one or two of the recent studies, the effect of moderate doses of caffeine taken in the form of tea or coffee is found to be a stimulation, producing an increase in the amount of muscular work done on the ergograph and the dynamometer. But although the careful work of Rivers confirmed these findings, his experiments designed to exclude all mental factors such as suggestion and interest show a much smaller increase than the earlier experiments. As in his work with alcohol he attributes this discrepancy to the failure of these workers to disguise the drug. Great differences were found by him in the susceptibility of different persons to the drug, and in the duration of the effect. The tests of speed of movement, motor coördination and steadiness, made by Hollingworth on sixteen subjects over a period of forty days, in which every known precaution against errors was taken, show interesting physical effects of caffeine. It produced an increase in the speed of movement,

the amount, which depends on the size of the dose, being about 4 per cent in a group of 12 persons. The doses ranged from 2 to 6 grains, the equivalent of which in terms of coffee and tea may be seen from the following figures:

Average cup of hot black tea contains	1.5 grains of caffeine
Average after-dinner cup of black coffee contains	1.5 " " "
Average glass of cold green tea contains	2.0 " " "
Average cup of coffee with milk contains	2.5 " " "

The effect was noted usually within an hour after taking and lasted from 1 to 4 hours, according to the size of the dose. What is perhaps one of the most important findings is that no secondary depression followed the stimulation for a period of 72 hours, when record taking ceased.

The motor coördination test, combining speed and accuracy of movement, shows a somewhat different result. Small doses produce stimulation, while larger doses, 4 to 6 grains, cause a retardation or decrease in efficiency following a brief initial stimulation. The greatest retardation noted for five persons averaged only 2.7 per cent. Individual differences were prominent, with clear evidence that the magnitude of the effect varies inversely with the body weight of the person. The steadiness test, de-

signed to give an indication of general nervousness, showed that doses of 1 to 4 grains produced slight nervousness, appearing several hours after the drug was taken. Larger doses of 6 grains produced greater nervousness, appearing sooner and increasing during a period of several hours.

Fewer tests have been made of the mental effects of caffeine. Only two will be mentioned. Rivers found an increase in typewriting speed with no influence upon accuracy and in the aiming tests mentioned earlier he found increased concentration of attention. Hollingworth used three groups of mental tests: (1) Association tests, including the naming of simple colors, naming opposites to each of a series of words, and problems in simple addition. In this group of tests, doses of every size from smallest to largest produced a stimulation, which reached a maximum of 15 per cent in the opposites test, and varied from this amount to very slight improvement in others. The effect lasted from three to seven hours, with no secondary reaction showing in any retardation that could be measured. (2) Choice tests, including the speed of perception and cancellation of specified characters from a large group of varied characters, and the speed with which visual objects could be discriminated and a movement appropriate to each be made. (Reaction by the right hand when a blue color was seen and by the left hand when a red color was seen.) In this group a rather curious effect was noted. Small

doses produce a retardation with decrease in quality of work. Larger doses, however, produce a stimulation within two hours, which may last until the following day. (3) Typewriting tests, concerning which Hollingworth says:

> The speed of performance in typewriting is quickened by small doses of caffeine and retarded by large doses. The quality of the performance, as measured by the number of errors, both corrected and uncorrected, is superior for the whole range of caffeine doses to the quality yielded by the control days. Both types of errors seem to be influenced to about the same degree. The increase in speed is not gained at the expense of additional errors, but increased speed and decreased number of errors are simultaneously present.

These experiments also present evidence of the effect of caffeine on sleep and general health, when rigid experimental conditions are in force. Extremely large individual differences were discovered. For most of the subjects, doses of 1 to 4 grains did not affect the quality or quantity of sleep; although there were a few individuals whose sleep was impaired. With doses of 6 grains, however, the sleep of most of the persons was disturbed although even here there were exceptions. The greatest effect was always obtained when the drug was taken on an empty stomach. The most important factor in producing the individual differences seems to be the differences in the body weight. As far as general

health is concerned, certain effects were manifested when the doses were larger than 4 grains. Headaches, dizziness, feverishness, irritability and the like were reported, especially by the subjects lightest in weight.

The experiments described lead to the following conclusion as stated by Hollingworth:

The widespread consumption of caffeinic beverages under circumstances in which and by individuals for whom the use of other drugs is stringently prohibited or decried seems to be justified by the results of experiment. But it should be emphasized that the results of the investigation here reported bear only on the more or less immediate effects of caffeine on performance. It is true that the investigation as a whole covered a period of 40 days, and that in the intensive experiment the effect of single doses was traced for a period of 3 days. But the results cannot be carried over bodily to the question of the continuous use of the drug. One can only assume that if the constant use of caffeine in moderate amounts would prove deleterious, some indication of such effect would have shown itself in the careful study of performance in tests covering a wide range of mental and motor processes, a wide range of doses and of individuals, and of time and conditions of administration. Nor can anything be said, on the basis of these results, concerning the physiological or neurological effect of caffeine, except in so far as integrity of structure can be inferred from unimpaired function or performance. . . . It should be further pointed out that . . . tea, coffee, and other caffeinic beverages . . . contain a variety of other substances which may be supposed to enhance or neutralize or otherwise modify the effect of the caffeine content. Many of the results commonly attributde to these

beverages undoubtedly come, in so far as they can be demonstrated at all under controlled conditions, from these non-caffeine ingredients.

Strychnine and Other Drugs.—Our interest has thus far been limited to the drugs which are well known and rather commonly used. Strychnine may not seem to belong to this class. It is prescribed by physicians as a bitter to stimulate the appetite and to heighten lowered nervous irritability. But numerous cases have been reported recently where strychnine has been taken on account of its supposed stimulating effects upon mental activity, hence it may rightly be considered as a factor in efficiency. Early experiments have indicated that strychnine caused a temporary stimulation followed by a reaction of the opposite type. Poffenberger recently tested the physical effects, as represented by its influence on steadiness, accuracy and speed of movement, and muscular work. Doses ranged in size from 1/30 to 1/20 grain. No effects were noted upon strength and endurance. The tests of speed and accuracy of movement indicated neither stimulation nor retardation. Only a slight decrease in steadiness appeared after the larger dose. The same investigator found neither stimulation nor retardation in a series of mental tests during the course of the experiment. As compared with caffeine, strychnine seems to affect the reflexes and lower centers of the nervous system, increasing their irritability and general sensitivity to external stimuli, while the

higher centers involved in mental activity are least affected; in the case of caffeine, it is just the higher centers which seem to be most affected. The physiological studies of these two drugs seem to bear out the conclusions just stated.

To postpone temporarily the onset of fatigue in tests of physical endurance, strychnine might be of service. But in the case of mental work, where the higher centers are involved, strychnine would be of no value. The influence of suggestion where such a supposedly powerful drug is concerned is tremendous, and if this factor were eliminated, it is likely that those mental operations and all other processes where popular opinion attributes such effects to strychnine, would not be influenced one way or the other by ordinary doses. How the long-continued use of large doses would affect efficiency remains to be discovered, but there are not the slightest indications that the effect would be beneficial.

Little need be said of the group of drugs including opium, morphine, cocaine, etc., as there is no question of their evil effects from the standpoint of efficiency. Certain experiments with cocaine have shown most remarkable temporary increases in strength, sometimes as high as 100 per cent. But they represent the group of habit forming drugs with all their demoralizing effects, and no transient effects would justify their use except under the direction of a skilled physician.

One of the most striking results of all work on

drugs is the discovery of great individual differences in response to varying doses, and especially in the resistance offered to large doses. This is a circumstance that prevents any recommendation of their use. The experimental work described in this chapter forces us to draw the conclusion that in every case except beverages containing caffeine, efficiency forbids their use. And even here, large doses taken for relatively short periods show disturbances in the general bodily economy of some individuals.

CHAPTER X

METHODS OF APPLYING PSYCHOLOGY IN SPECIAL FIELDS

In the various practical fields there are three ways in which, in the past, psychological work has been accomplished. These three methods we may conveniently designate: (a) application of the psychological attitude; (b) application of psychological knowledge; (c) application of psychological technique.

The Psychological Attitude.—Especially characteristic of psychology as a science is the attitude of analysis. Geography and geology are concerned mainly with the description of their materials, and neither the geographer nor the geologist commonly takes a strictly analytic attitude toward these materials. The botanist and zoölogist are mainly engaged in classification, the physicist mainly in measurement, the physician mainly in effecting changes in his patients. The psychologist, on the other hand, especially in the earlier stages of his science, has been much occupied with the analysis of his materials into their elements and constituents. Thus he analyzes an action into its stages, an emotion into

its simpler component feelings, a thought process into its various aspects.

In practical life the worker commonly fails to make such an analysis of the materials and tasks with which he deals. The whole task or the whole material commonly stands out as a unit or mass, given once for all in its entirety. But such an unanalytic attitude often results in inefficient work and superfluous endeavor. Thus the art of education made a definite advance when the task of the teacher was analyzed into the various separate steps involved in preparing, arranging, presenting, impressing and applying the subject matter of the recitation. Only when such an analysis was made was it possible to trace to their sources the various factors and influences which had up to that time remained obscure or refractory. Similarly the work of the advertising writer is facilitated when he ceases to think of his task as a single act, "writing an advertisement," and realizes that in this act there is a considerable variety of separate tasks or processes into which the whole may be analyzed. The salesman comes in time to realize that "making a sale," although apparently continuous and simple, comprises in reality a complex series of steps, such as those now commonly designated "approach," "presentation," "arousal of interest," "argument," "closing the deal," etc.

Taking such an attitude of analysis toward one's practical work is then one of the most useful meth-

ods of improving skill and detecting the sources of inefficiency. Even so unitary a task as "washing the dishes," when analyzed into the various distinct steps which make it up, yields itself to more scientific study. Thus Christine Frederick, in making such a scientific examination of this household task, writes:

> When we say "dishwashing" we commonly think of a single household task. But when closely analyzed and made the subject of a time or motion study, we see that it is composed of several parts or steps, each with different motions, and generally performed with different tools, as follows:
>
> 1.—Scraping waste from surface of china, agate, or other kind of dish or utensil.
> 2.—Stacking or arranging dishes on surface adjacent to sink preparatory to washing.
> 3.—Actual washing with water, soap or other cleanser, with aid of cloth, mop, or other mechanical means.
> 4.—Rinsing dishes with clear water.
> 5.—Wiping dishes with towel or equivalent drying.
> 6.—Laying away dishes on or in respective shelves and cupboards.
>
> The efficiency of the whole process of "dishwashing" can be improved only by increasing the efficiency of each separate step.

By the same type of analysis Gilbreth was enabled to treble the work of bricklayers, and various management experts have been enabled to discover the sources of loss, waste, fatigue, and accident. Such work may justly be called psychological, inasmuch as it involves a special mental attitude, inasmuch as

the materials thus analyzed are commonly human movements and general behavior, and inasmuch as the training of the psychological worker seems especially to prepare him for such an analytic method of approach.

Applying Psychological Knowledge.—Quite distinct from the attitude of analysis is that procedure in which one acquires certain established facts or laws concerning mental processes or behavior, and, carrying them over into his practical work, applies them directly to some concrete problem there encountered. This we may designate the application of psychological content or knowledge. Thus in the work of the printer and typographer, numerous facts concerning the psychology of reading and the laws of perception may find direct application. The appropriate size of type, the length of printed line, choice of font, spacing of letters and words, use of borders and ornaments, brightness of paper, color of ink, amount of white space, plan of indentation and arrangement and a host of definite problems of immediately practical value can be solved correctly only through the application of some badly understood rule of thumb, or, more intelligently, through reference to the laws of visual perception.

The case of the pedagogy of reading affords an interesting instance of this type of application. Psychological studies revealed the general law that the process of perceiving a new object and comprehending its meaning is an analytic rather than a

synthetic act. We commonly get first an impression of the whole, then gradually or on later occasions discriminate out of this whole or within it the elements which compose it. Using words and letters as objects of experiment, it was found that one could correctly read words which were so small, so far away, so out of the line of fixation, or so swiftly exposed, that the separate letters could not be correctly identified. The words appeared to be recognized by their characteristic form rather than by the putting together of the separate letters. So strong is this tendency to perceive the word as a whole, by its "word form," that misspellings may easily fail to be noticed even when one is earnestly searching them out. Up to this point the facts are but an interesting bit of psychology. But as soon as teachers of reading perceived the significance of these facts, the whole procedure of teaching to read was revolutionized. No longer was the struggling pupil required first to learn his dreary A, B, C's, and then to put the various letters together in the form of syllables, which in turn must be combined to form the more interesting and meaningful words. Instead he was taught much more quickly and much more interestingly by the "word method," in which he rapidly became familiar with a variety of words and phrases and their meanings, and later, by a much more natural or psychological process, came to observe the separate syllables and letters of which each word was composed.

In numerous practical fields the laws and facts of psychology may be thus applied to some practical end. In salesmanship a knowledge of the laws of suggestion; in advertising, the laws of attention and interest; in study, the facts of memory; in management, the knowledge of the motives and impulses of men; in animal training, the laws of learning; in politics and oratory, the tendencies of crowd formation and group behavior; in the decorative arts, the laws of esthetic reaction; in literature, the acquaintance with the range and complex interrelations of purpose and emotion; in industry, the psychological laws of work and rest, fatigue and inhibition, habit and distraction; in social work, the facts of mental abnormality. In fact there would seem to be no end to the catalogue of practical fields in which familiarity with the laws of mental life may be utilized to direct advantage. Indeed, it is this type of application which most commonly comes to mind when "applied psychology" is mentioned.

Application of Psychological Technique.—Finally there is the third type of application, which is rapidly coming to be even more definitely useful than the "knowledge of human nature" just described. This is the type of work in which one does not necessarily proceed by assuming an attitude of analysis, nor yet by bringing over bodily some piece of psychological lore or knowledge. Instead, in this form, one adapts to the solution of his special practical problem some method of procedure, some stand-

ardized technique, or some special form of apparatus originally developed in the psychological laboratory.

For numerous reasons the psychologist has found it necessary to devise methods of investigation peculiar to his science. Among these reasons may be mentioned the variability, complexity and delicacy of the materials which he studies. Countless sources of error confront the psychological worker, with which the other sciences do not have to contend. Thus, in measuring the expansion of a piece of iron under the influence of varying temperature it makes no difference whether the observations are made in the morning or at midnight, on Monday or on Saturday, by a male or female, young person or adult, in India or in Africa, with the right hand or the left hand. None of these factors influences the reaction of the piece of iron. But in even the simplest of psychological measurements,—whether of the keenness of vision, the flow of images, the sequence of ideas,—any or all of these and a host of other variables may influence the outcome. In order to take into account these manifold conditions and in order to detect, underneath all the complex variables, the direction of the processes uppermost in interest at the moment, an experimental technique is required which is more refined and precise than that of any other branch of science. In many cases also the apparatus used and the mode of graphic record employed are particularly delicate. Especially im-

portant, however, are the control of conditions, the elimination of sources of error, and the mathematical and statistical methods of computation.

Consequently in many practical fields, such as medicine, law, industry, teaching, management, legislation, marketing, where the "human element" is a conspicuous factor in the success or failure of an enterprise or an inquiry, it is found useful to carry over either completely or in a modified form the technique, procedure, or apparatus originally devised for the solution of the problems of general psychology. In such cases the results are not always of value to psychology as a science, although this may often be the case. In general, however, the result is a solution of the particular practical problem in its particular setting, and as such may be of great concrete value.

Thus, in the general field of medicine the psychological technique is found to be the only one adequate to answer many questions concerning the immediate effects of drugs, and of such factors in the environment as humidity, temperature, fatigue, posture. In the treatment of various types of disorder also, psychological technique is found to be the most effective. In business the laboratory methods have been effectively applied to the measurement of advertisements and sales points, packages, trade-marks, trade names, etc. In industry the application of "reaction time" technique and apparatus has become the "motion and time study"

of the modern workshop. In law the "recognition method" is coming to be used in the measurement of infringement and the validity of testimony; the "methods of mental measurement" are used in the determination of responsibility; and the "methods of expression" in the accumulation of evidence and the discovery of guilt or knowledge.

The utilization of psychological attitude, psychological knowledge, psychological technique, then, affords the three principal ways in which psychology may be "applied" in the various practical fields, and in which these practical fields may aid in the development of "applied psychology." These three methods have not in the past been found equally serviceable in all the various fields of practice. In the chapters which follow, certain fields are presented in which one or more of these methods has been sufficiently used to make some material contribution either to psychology as a science or to the concrete practice of daily life.

CHAPTER XI

PSYCHOLOGY AND THE EXECUTIVE

From the point of view of one engaged in the active supervision of industrial and commercial enterprise the three chief ways in which the attitude, content and technique of psychology may be put to practical use are (a) in the selection of employees through a more adequate vocational diagnosis of their general mental capacity or their special aptitudes; (b) in the organization and management of groups of workers through the effective provision of incentive and reward and through competent instruction and training; and (c) in the provision of the most effective environmental conditions.

Selection of Employees.—Since not every kind of work can be done equally well by any individual, misfits in vocation are constantly occurring. Incompetents are often placed in responsible positions or otherwise competent persons placed at tasks for which they may be found to have either no inclination, a strong dislike, or perhaps no particular aptitude. Unless great care is exercised, therefore, the employees in large commercial and industrial concerns may easily become a shifting population, aban-

doning their work for want of interest in it or being dismissed for unsatisfactory service. In many such cases the "labor turnover,"—the number of individuals who enter the employ of a given firm during a given period of time, as a year, may amount to five or even ten times the number actually working at any one time. This means loss through inefficient service, through the constant necessity of training new workers and through the maintenance of a complicated and busy employment and training department.

The executive or employer has been so eager to find some means of reducing this loss that he has taken up one after the other a variety of aids which either pretended or seriously attempted to enable him to fit the worker to his appropriate task. Impressionistic interviews, photographic analysis, letters of recommendation, letters of application and application forms, phrenological and physiognomic descriptions, and numerous other diagnostic aids have in turn been tried and found to be either utterly absurd or manifestly inadequate to determine either general or specific fitness.

In recent years the interest in the development of mental tests and scales, primarily for the determination of general intelligence or for particular school abilities, has led to the hope that in addition to such value as these intelligence and product scales obviously have in vocational selection, specific tests might be devised which would measure such par-

ticular aptitudes as might be demanded by a given type of work. If tests could be provided which would enable the employer to select, from a list of applicants, those most likely to be successful at the work in question, this would greatly decrease the loss which all the other aids to selection seem unable to reduce. Even sets of tests which would be inadequate for the vocational diagnosis and guidance of the individual might still be of inestimable use to the employer.

The most fruitful method of discovering relationships between tests and aptitudes for various kinds of work seems, from the experience of many concerns who are now utilizing such aids, to be as follows: A group of workers whose relative abilities in the work in question are already fairly well known and capable of expression in quantitative or at least in relative terms, is chosen. To these individuals, good, average and poor, are given as many forms and varieties of psychological tests as the patience of the worker, the zeal of the experimenter or the interest of the employer makes possible. Ability in each test is then compared with ability in the work. Certain tests may in this way be found which serve as indices of occupational capacity,—good workers perform these tests well, poor workers do them poorly. Of thirty or forty tests thus tried out perhaps only four or five will seem to possess this diagnostic significance, and only these four or five are retained as tests for the type of ability in

question. If these results now stand the test of repeated trial and constantly correlate with the occupational success or failure, the employer has secured a valuable instrument which may be used in the examination and selection of new employees from lists of applicants.

With these successful samples as a basis the psychologist may devise further tests which seem to involve similar principles or call for similar types of special proficiency. He will also be interested in discovering the reasons for this particular correlations, and may thus be able to throw new light both on business practice and on the work of his science.

By such methods and their elaboration there have already been devised or selected tentative sets of occupational tests for a considerable variety of types of work. Conspicuous in this form of applied psychology is the work of Scott in the formulation of tests for salesmen and that of Thorndike and his co-workers in the derivation of tests for various types of clerical, mechanical and academic work. Münsterberg advocated the use of various tests devised in his laboratory for aid in vocational selection, his own interest lying in the ingenious suggestion of types of test rather than in the careful determination of their actual validity. Following the lead of Thorndike, Scott, Münsterberg and others there has come to be at the present day a wide-spread activity in this field. Some of the teams of tests that have resulted from this type of

investigation are given in the following Table. The tests are for the most part such as are familiar by name to the psychological worker and no attempt can be made here either to describe them or to give standard procedure for their administration. The practical reader should, however, be cautioned that psychological tests are of no value unless in their administration, scoring and weighting the standard procedure is followed. In each case the figures following the name of the test indicate the actual degree of correlation between performance in the test and some objective measure of occupational proficiency. It may safely be said that all of these correlations are higher than those between the usual off-hand or traditional methods of selection and actual proficiency.

Tests for Vocational Selection

(The tests are indicated by their conventional laboratory name, and the figures in each case indicate degree of correlation between ability in the test and some objective measure of ability in the actual work of the vocation. [Data from Allen, Jones, Lahy, Lough, McComas, Rogers, Scott, Trabue, and others].)

STENOGRAPHERS		TELEGRAPHERS	
Naming Opposites.....	.45	Immediate Memory....	.52
Form Substitution.....	.40	Naming Opposites.....	51
Following Directions...	.46	Completion	52
Color Naming.........	.34	Substitution	.39
Letter Substitution....	.82	School Grade..........	.77

CLERICAL WORKERS

Directions	.57
Naming Opposites	.55
Part-Whole	.49
Whole-Part	.65
Completion	.59
Absurdities	.36

MINOR EXECUTIVES

Better Reasons	.76
Absurdities	.46
Completion	.43
Mixed Relations	.46
Part-Whole	.46
Opposites	.36
Color Naming	.46

SPECIALIZED OPERATORS

Color Naming	.32
Form Naming	.48
Completion	.71
Aiming	.62
False Statements	.67
Absurdities	.56

CORRESPONDENTS

Naming Opposites	.40
Following Directions	.54
Mixed Relations	.43
Color Naming	.38
Action-Agent	.35
Agent-Action	.37
Verb-Object	.37

TYPEWRITERS

Number Checking	.53
Letter Substitution	.96
Color Naming	.45
Action-Agent	.43
Verb-Object	.55
Memory Span	.50

HAND SEWING

Tapping Rate	.34
Following Directions	.53
Naming Opposites	.41
Color Naming	.43
Logical Memory	.37

LABEL PASTING

Knox Cube	.73
Card Sorting	.42
Substitution	.50
Naming Opposites	.41
Color Naming	.51
Following Directions	.50

MACHINE STITCHING

Mixed Relations	.58
Logical Memory	.36
Accuracy of Aim	.44
Naming Opposites	.44
Color Naming	.36
Following Directions	.38

ENGINEERS

Completion	.63
Card Sorting	.47
Construction	.35
Invention	.66
Omnibus	.66
Imagination	.66

The degree of correspondence between such mental tests and success in a definite type of work is shown by the following instance: Fifty salesmen, engaged in selling all manner of commodities in all manner of ways, ranging in age from twenty to fifty years, and of course having had varying amounts of experience, were examined by means of three sets of selected mental tests. In the case of each individual his present salary was divided by the number of years of selling that had enabled him to attain that salary. This measure of success as a salesman is admittedly a rough one, but no more satisfactory measure could be devised for comparing the members of so heterogeneous a group. The individuals were then arranged in four groups in the case of each of the sets of tests, according to the score attained, giving groups which might be designated as superior, good, fair and poor. Then the average salary per year of experience was computed for each of these groups. The results are given in the following table:

COMPARISON OF ABILITY IN TESTS WITH ABILITY IN SALESMANSHIP

Test Series	Score	Salary per year of Experience	Probable Error	Number of Individuals
Series I, Tests for Judgment, Comprehension, etc.	Over 550	$765	$170	11
	400-550	968	168	15
	250-400	934	138	19
	Under 250	612	111	5
Series II, Tests for Perception, Discrimination, etc.	Over 230	1085	197	8
	215-230	845	157	9
	200-215	829	91	21
	Under 200	674	80	12
Series III, A Test for General Intelligence.	Over 40	1161	256	10
	30-40	833	108	19
	20-30	822	113	17
	Under 20	492	106	4

The mental tests, although their administration required only thirty-five minutes, are seen to divide the salesmen in a fairly reliable way into groups of superior, good, fair and poor earning power, and to this extent would seem to be of genuine value in differentiating the members of the group on the basis of their proficiency in selling.

Organization, Management and the Psychological Attitude.—In the intensive study of methods of in-

dustrial organization and management that has been going on in recent years the psychological factors have been found to be as important as the mechanical, technical, accounting or distributing machinery. "Experience has clearly demonstrated," says Gilbreth, "that the emphasis in successful management lies on the man, not on the work; that efficiency is best secured by placing the emphasis on the man and modifying the equipment, materials and methods to make the most of the man. It has further recognized that the man's mind is a controlling factor in his efficiency, and has, by teaching, enabled the man to make the most of his powers. In order to understand this teaching element that is such a large part of management, a knowledge of psychology is imperative." It should also be said that the problems of management constitute an inviting field of research for psychology, as well as an immediate field of application.

The value of the attitude of analysis is clearly shown in the various attempts to reduce the work of management into its "elements" or "principles." The well-known Taylor system of management stressed nine chief factors as making up the work of management, thus taking a psychological attitude toward what might otherwise have been considered as a single task. Once such an analysis had been satisfactorily made it was possible to apply it to the most varied institutions and organizations. The management of a factory, a hospital, a kitchen,

an army, an athletic team, a newspaper office, or even the human body, was found to be greatly facilitated, ordered and improved by the mere act of considering it from this analytic point of view.

Furthermore every one of these elementary phases of management is seen at once to involve the application of the laws of human behavior, or through its problems to call for the utilization of the technique of psychological research. It may be profitable to consider some of the "elements" of modern systems of management for the sake of indicating the psychological problems and principles which they suggest. Under one such system, for example, the "elements" are stated to be,—individuality, functionalization, measurement, analysis and synthesis, standardization, records and programs, teaching, incentives, welfare.

Individuality and Differential Psychology.—Under the traditional forms of management the "gang" was the unit of operation, record, remuneration and teaching. There was but little effort made to select or adapt the individual according to his idiosyncrasies, to instruct him individually or individually to record or reward his work. Under modern systems of management the psychology of individual differences is important, and the individualization of management takes its place in history with the individualization of pedagogy and the individualization of punishment. Thus Gilbreth writes:

Under scientific management the individual is the unit to be measured. Functionalization is based upon utilizing the particular powers and special abilities of each man. Measurement is of the individual man and his work. Analysis and synthesis build up methods by which the individual can best do his work. Standards are of the work of an individual, a standard man, and the task is always for an individual, being that percentage of the standard man's task that the particular individual can do. Records are of individuals and are made in order to show and reward individual effort. Specific individuals are taught those things that they individually require. Incentives are individual, both in the cases of rewards and punishments, and finally, it is the welfare of the individual worker that is considered, without the sacrifice of any for the good of the whole.

Still more recently, under such terms as "industrial democracy," the plan of organization is such that the workers constitute their own management, or have a decisive voice in determining the general policies covering such matters as hours of work, method of remuneration, selection of foremen, or through ownership of stock or some form of profit-sharing system, become virtual partners in the enterprise.

Functionalization and Its Mental Effects.—By this process is meant (a) the analysis of the work into its primary elements or tasks, such as planning, recording, repairing, teaching, supervision, etc.; and (b) specializing the worker by assigning him to that task in the industry for which his particular capacities, whether as laborer, foreman, teacher,

executive, best qualify him, and thereby (c) reducing his functions or intensifying them. Thus one of Taylor's stated principles was,—"Each man from the assistant superintendent down shall have as few functions as possible to perform." Innumerable psychological problems are involved in this principle,—not only those of adequately determining the special qualifications and interests of the individual, but, supposing this to be accomplished, the problem of determining the effect of such restriction of activity upon the worker himself, the educational advantages and defects of unvaried performance, problems of ennui, monotony, interest and general mental attitude. It is obvious that the psychological effects of management systems are as important and concrete as are the psychological factors involved in their application.

Measurement and Psychological Technique.—Inasmuch as both individual recognition and specialization depend on the determination of the qualifications, success and performance of each person concerned, measurement of human factors is one of the important aspects of modern management. The effects of variables in environment, tools, and methods of work must be accurately made out, and this calls for the development of special technique. Since most of the measurement is of human reactions, practice, skill, adaptation, fatigue, improvement, etc., the graphic and statistical methods long used in the psychological laboratory are find-

ing a place in the industrial laboratory as well. They are receiving there, in the hands of skillful and zealous investigators, various forms of modification, elaboration and refinement which may well be expected to enhance their value for direct psychological and educational research. Furthermore, it is being found that for the accurate measurement of industrial products it is in many cases necessary to devise scales of measurement, similar to those which psychologists have devised for the measurement of such school products as writing, drawing, composition, etc. Such measurement is especially necessary when the industrial product may vary in quality as well as in amount. An example would be found in the formation of a graded scale for the measurement of hand sewing in which the successive steps would be represented by actual specimens, arranged, by a special laboratory technique, in order of ascending value, and so chosen that the steps from one sample to another are in all cases equally perceptible.

Analysis, Synthesis and the Instinct of Workmanship.—Under this head comes the interesting problem of the psychology of workmanship. Most important is the fact that the testimony of the experienced executive seems to contradict the assertions of many who have been interested in recording the original tendencies of human beings. According to Veblen, "Efficient use of the means at hand and adequate management of the resources available

for the purposes of life is itself an end of endeavor, and accomplishment of this kind is a source of gratification." This proclivity for workmanship is said to be "chief among those instinctive dispositions that conduce directly to the material well-being of the race," and is comparable in its influence and urgency with the "parental bent." "The instinct of workmanship brought the life of mankind from the brute to the human plane," etc.

On the other hand, those actively engaged in the work of management are found to insist that one of the greatest evils of industry is the original tendency to "soldier" or "loaf on the job," to follow old rule of thumb methods of work, and to resent any effort to introduce more effective and productive technique. "This loafing or soldiering," says Taylor, "proceeds from two causes. First, from a natural instinct and tendency of men to take it easy, which may be called natural soldiering. Second, from more intricate second thought and reasoning, caused by their relations with other men, which may be called systematic soldiering."

Whether or not the survival of ineffective methods in all forms of work results from present economic, social and managerial conditions, or whether the "instinct of workmanship" must needs be abandoned as an original tendency in human nature is in itself a psychological problem of no little interest. But of more immediate consequence is a fact on which managers and teachers commonly agree.

This fact was well stated by Taylor in the following words:

> In practically all of the mechanic arts the science which underlies each workman's act is so great and amounts to so much that the workman who is best suited to actually doing the work is incapable, either through lack of education or through insufficient mental capacity, of understanding this science.

The incompetence of the worker to understand the science underlying the operations in which he is individually engaged makes necessary the analysis of these operations by some more expert observer, and the synthesis of their elements into a procedure which is scientifically ordered. This at once involves the next principle, that of standardization.

Standardization and the Psychology of Habit.—Standardization depends on the psychology of habit. The beginner at any type of skilled work, as typewriting, inevitably adopts a method which, though it may give the greatest immediate return, is not in the long run calculated to be most effective. Practice in such an ineffective work method establishes a habit of performance which not only delays the formation of more appropriate habits, but may positively interfere with their development when an effort is made to acquire them. Faulty habits, whether in holding a violin, in mastering a keyboard, in handwriting, in the use of words, in brick-

laying, shingling, carrying loads, cutting metals or in handling simple or complicated tools or machinery, mean personal, industrial and professional waste.

An important function of management in its scientific form consists in supplying the results of analysis, synthesis and expert study to the work in the form of standards of practice. Standards of practice mean, in this sense, habits of work which expert study shows to be ultimately, though perhaps not immediately, best calculated to promote the efficiency of the worker.

Standardization goes even farther than the prescription of the most effective attitude and method on the part of the worker. Not only is there a standard method of ultimately mastering the keyboard of a typewriter; that keyboard is itself standardized in such a way that when the operator passes from one machine or office to another the effective habits that have been once acquired will fit the new circumstances as well. Just as in the more strictly engineering features of industry it is found necessary to standardize such things as the size of nails and screws, the dimensions of bearings, pipes, wheels, tires, rails, etc., so the tools of the human worker,—the keyboards, the signals, the filing systems, the sales slips, etc., should be standardized so as to fit the established habits of the worker.

But still further, when work habits and tools are thus standardized, it becomes possible to standard-

ize performance itself in such a way that the worker who achieves, falls below, or exceeds the standard performance may be readily identified, rewarded and promoted. In this way the formation of standards, which may often seem, in the beginning, to constitute a violation of the principle of individuality, may be in the outcome a necessary means of attaining that end.

Records, Programs and Educational Psychology. —"A man's social use," says James, "is the recognition which he gets from his mates. We are not only gregarious animals, liking to be liked in the sight of our fellows, but we have an innate propensity to get ourselves noticed, and noticed favorably, by our kind." Such recognition the worker is afforded by the keeping of accurate records, by their publication or posting, their use in the assignment of reward or bonus, in the formulation of programs and schedules, and as a means of self-stimulation. The competitive social impulse may show itself in wholesome rivalry. In so far as this is possible it is more psychologically sound for the worker to keep his own records, inasmuch as this facilitates a direct comparison of achievement with his personal experiences and effort, and especially since it encourages that most psychological of all forms of rivalry,—competition with one's own record.

The actual graphic representation of such records by the worker or by the management from time to time, in the form of curves of learning, curves of

work, curves of diurnal variation, curves of fatigue, accident curves, etc., is one of the most effective ways of stimulating initiative and encouraging understanding. Practice without knowledge of results is much inferior, as a pedagogical procedure, to practice accompanied by constant awareness of the quality of one's performance.

An interesting and practically important trait of human nature is the desire for some symbol whereby one's status may be socially established and declared. Not only do men work for wages and salaries,—they may also be effectively rewarded by titles, honors, badges, buttons, privileges, or by any simple device which facilitates or establishes social recognition. One of the most potent devices of our childhood, however artificial it may have been, was the "reward of merit" card, which was a sufficient inducement to stimulate us to earnest though wageless work in arithmetic and geography. Professional, administrative, political and military workers not infrequently prefer change of title to advance in salary. The college student puts high value on his pins, letters, and similar emblems. The importance of the symbol as a type of reward finds just recognition in the organization, training and management of groups of operatives, salesmen, and similar workers.

Incentives, Welfare and Social Psychology.— Under this heading come a host of managerial and executive problems in which human nature plays

an important rôle. Much of the literature on the various types of compensation or wage systems takes its stand on one or another characteristic of human instinct, desire, satisfaction, responsiveness, expectation, assurance, incentive or failing. The most striking feature of the various modern systems of management has been their discarding of the traditional incentives of fear, punishment, and compulsion, and the placing of emphasis on such factors as initiative, mental attitude, coöperation, loyalty, professional pride, etc. In one of the most recent movements the slogan, "industrial democracy" means simply that the worker takes a responsible part in his own management, and that the "direct" incentives, such as ambition, pride, fairness, love of the game, loyalty and social recognition take the place of the "indirect" incentives of wages, punishment, discharge and necessity.

There is no more familiar fact of psychology than that the presence of an incentive or motive, arising, if possible, in a spontaneous and personal way, is a more important condition of effective work than any number of environmental details. Taylor, in referring to the influence of the "gang" on the individual worker, says:

> As an illustration of the value of a scientific study of the motives which influence workmen in their daily work, the loss of ambition and initiative will be cited, which takes place in workmen when they are herded into gangs instead of being treated as separate individuals.

He then points out that under such circumstances the characteristic result is for the individual efficiency of each man to fall to or below the level of the poorest worker in the gang.

On the other hand, it is well known that if an element of contest can be introduced, and one group, composed of workers who are bound by some physical, social, religious or political sympathy is put in competition with another group, the gang spirit may work in just the reverse direction. Thus Gilbreth found that with teams of bricklayers extra zeal and effectiveness was produced by putting tall men on one job and short ones on a competing task. Such oppositions as married vs. single men, eastern vs. western men, and national groupings, were equally effective. There are plenty of illustrations in anyone's experience to show that working in company does not necessarily level down efficiency to the basis of the least effective worker. Companionship, friendliness, the consciousness of mutual endeavor, may easily work to increase the average level. The important point is whether the individual, in company, receives due recognition as an individual, either on his own responsibility or as a member of a "team" rather than of a "gang."

Psychological Influence of the Environment.—In a previous chapter, in connection with the conditions of personal efficiency, a variety of factors are discussed with which the scientific executive or manager should be familiar. Of particular impor-

tance in the local management of workers are such factors as illumination, ventilation, posture, fatigue eliminating devices, rhythm, etc. Not only do the environmental factors in many cases exert a demonstrable influence on effectiveness of work, but the worker in turn acquires work habits with respect to these environmental factors. These work habits may be as important as the external influences themselves.

In many cases the arrangement, elevation and slope of the benches, work tables, chairs, etc., make the posture of the worker a feature that cannot be neglected. The fact that posture has a genuine influence on the effectiveness of work is not only a matter of common experience, but the degree of this influence is susceptible of quantitative measurement. One psychological investigator, impressed with the prevalent tendency on the part of acquaintances in a college dormitory to do their studying with their feet perched on a table or shelf, higher than the head, conducted a series of experiments on the effect of posture. Inquiry among men of eminence revealed the fact that there was a widespread preference for a horizontal posture in the performance of mental work. The investigator put these matters to scientific test by arranging a tilt board on which an individual could be placed and tipped at angles ranging from the vertical or erect to the horizontal position.

Tests were then conducted in which the individ-

ual's ability was measured in the horizontal and vertical positions. The tests included measures of ability in visual memory, discrimination of pitch, tactual perception, auditory memory, mathematical calculation, fatigue, speed of movement and strength of grip. In the case of the abilities which may be described as mental rather than muscular, the horizontal position was clearly superior, not only in the averages but consistently with different individuals. In the case of the more muscular activities the vertical position was found to be most favorable. Clearly even such apparently trivial factors as the position of the body, as determined by the apparatus and paraphernalia of work, the disposition of furniture and materials, may be of as much practical importance as the care and oiling of machinery or the promptness and punctuality of employees.

The importance of lighting systems and of efficient illumination has already been pointed out. Tests of visual acuity, which indicate the ability of the eye to see correctly and to discriminate finely, show that so simple an error as that of having a light directly in the field of view may decrease the worker's visual efficiency from 25 to 30 per cent. It is, moreover, certain that various forms of eye strain, aggravated in many cases by imperfect illuminating systems, are among the important causes of nervousness, headache, drowsiness and

fatigue, which may in many cases contribute toward the production of industrial accidents.

Recent studies of the effect of various factors in the ventilation of the workshop seem to indicate that these factors do not operate in a direct physical or physiological way, but, in so far as they are effective, largely in a psychological manner, by doing violence to the worker's customary working habits, by distracting his attention, or by decreasing the comfort or satisfyingness of his work, rather than by decreasing his actual ability. Such investigations as those of the New York Ventilation Commission are of great scientific as well as practical value, especially since they seem to indicate that even such striking environmental factors as temperature, humidity, circulation of air, carbon dioxide, etc., exert their chief influence on working capacity indirectly, through their psychological effects, rather than physiologically or physically.

Recent inquiries into the causes of industrial accidents indicate that at least 80 per cent of them are not due to faults in machinery or to unavoidable physical catastrophe, but to the failure of the human mechanism, either of the sufferer or of a fellow worker. In the efforts to discover the precise nature of these human sources of danger, various suggestions have been made. The most common explanation is that which attributes such accidents to carelessness. But the fact that such accidents are not distributed uniformly through the working hours

suggests that if carelessness is the responsible factor there must be sought some further reason why carelessness asserts itself so much more dangerously at some hours than at others. Some investigators have suggested fatigue as the responsible factor. But the curve of accidents through the day does not follow the course of fatigue, as measured during a day's work. The greater numbers of accidents do not come at the hours when the worker, since fatigued, is less efficient. On the contrary, they come at precisely those hours when the speed of production is the greatest and the workers doing their most effective work. Hence the suggestion has also been offered that accidents are likely to result at such times, because the worker's attention is drawn to the machinery and materials rather than toward his own body, and the protective reactions fail which would be more operative at a slower rate of work. It has also been shown that even during a short period, such as twenty minutes, of work similar in character to that which the machine operator in a highly specialized industry would perform, there is a clear tendency for accidents or failures and errors to be more frequent in the latter half of the period than in the earlier half. When one observes the extremely simple and automatic character of the movements involved in these factory operations it is not surprising to be told that the monotony of the work suffices in a few moments to induce wandering attention and absent-mindedness

in the operator. Simple as the operations are, it is nevertheless true in many cases that an exceedingly small error in movement may involve the worker in serious accident. Whatever ultimate conclusions may be reached as to the factors underlying human carelessness in industry, it is clear that they will be found to be factors studied by the psychologist rather than by the mechanic or engineer.

Finally among the environmental factors may be enumerated a variety of influences which, because of their power to stimulate effort or efficiently organize work, have been called "dynamogenic." Perhaps the most familiar of these is rhythm. The writer recalls having seen, in a foreign city, a group of laborers tamping in the cobblestones of a pavement with special blocks of iron attached to a handle. These implements were alternately raised into the air a foot or so and then brought down on top of a refractory cobblestone, which was thereby driven into place. But the workmen were not tamping away, each at his own indiscriminate rate. Along the curb walked a foreman who beat with an iron bar a rhythmic series of strokes, which was followed in unison by the workers on the cobble. In this way they proceeded merrily and efficiently up the street. It appeared that the management found it more effective for one man to do nothing but beat the rhythm, than for all workers indiscriminately to wield their implements. The rhythm of

work songs, sea songs, college yells, drum beats and the marching tune demonstrably so organize the individual's movements that they proceed more harmoniously, more regularly, more effectively and with less effort. Teachers find that in the class room, in conducting drills, or in various types of practice exercises, much may be gained by the imposition of more or less artificial rhythms which are in no particular way related to the habits being formed.

In drill on column addition successful work is done by placing the problem on the board and following through the combinations by pointing the pointer and making a tap on the board as one proceeds through the column. Concert work of this sort seems to have the effect of speeding up those who would ordinarily lag, even though they might get the right result. The most skillful teachers of typewriting count or clap their hands or use the phonograph for the sake of speeding up their students. They have discovered that the same amount of time devoted to typewriting practice will produce anywhere from twenty-five to one hundred per cent more speed under such artificial stimulation than they were in the habit of getting merely by asking the students to practice.[1]

Not only does rhythm thus organize the work of the individual, but it also organizes the individuals into a more effective group, inspirits effort and gives swing, drive and purpose to otherwise monotonous and wearisome work. In this sense it may with

[1] Strayer and Norsworthy, "How to Teach," p. 205.

perfect right be called "dynamogenic," and may be in many ways put to both practical and interesting uses. In a similar or related way such external factors as color, odor, scenery, clothing, novelty, friendliness and cordial associations have their stimulating and practically dynamogenic influences.

In this chapter we have by no means attempted to give a complete picture of the importance of psychology for the executive. But from what it has been possible to present in so limited a discussion it should be clear that, not only in the selection of workers but in their management as well, the types of psychological application and the settings of psychological problems are both varied and numerous. In the analysis of management into its elements the psychological attitude and point of view are conspicuous. In the concrete managerial duties and in the provision of favorable environmental conditions psychological knowledge is found to be indispensable. The experienced executive can narrate a wealth of incidents in which the discernment of some simple law of feeling, motive, or thinking contained the solution of a difficulty. Finally, in the selection of workers, and in the solution of numerous problems growing out of the managerial analysis, psychological technique and apparatus are becoming increasingly useful.

CHAPTER XII

PSYCHOLOGY IN THE WORKSHOP

In the preceding chapter we have considered some of the ways in which the psychological factors enter into the work of organization and management. In the case of the worker himself, his methods, attitudes, modes of attack, distribution of effort, choice of tools, routing of operations and arrangement of materials, the laws of mental and motor effectiveness are no less important.

Mental Set and Shift.—A concrete illustration of the influence of these mental factors is to be found in the case of what is known in the psychological laboratory as the maintenance of mental set. A simple experiment will make clear the meaning of this term. Arrange a series of given words for which both synonyms and antonyms may be found, —words of similar meaning and words of opposite meaning. The experiment is as follows: First go down the column, calling aloud an acceptable opposite for each word, letting someone record the time required to complete the series. Then go down the column again, but this time calling out synonyms instead of opposites, and again recording the time required. In the third case go down the column

again, calling out an opposite for the first word, a synonym for the second, an opposite for the third, a synonym for the fourth, and so on down the list, alternately. Record the time as before, and also notice whether this time the work seems more or less difficult than in the first two times. The results may be still clearer if the experiment is repeated several times, thus giving each method a fairer measurement.

In the case of columns of numbers the reader may perform a similar experiment by first adding 17 and subtracting 17 alternately, then adding 17 in each case, then subtracting 17 in each case. Here again the experiment should be performed several times and the results averaged, so that greater difficulty does not attach to one method simply because it was the first one tried. Quite uniformly it will be found that the mixed series is felt to be more difficult and actually requires more time than either of the other two.

In general it is found that shifting back and forth from one mental set, one attitude or task to another is a relatively ineffective mode of work. This principle has many applications in the workshop. House cleaning has been shown by actual trial to move more expeditiously if one first sweeps all rooms, then dusts all rooms, then polishes all furniture, then arranges all contents, than by the more commonly observed method of sweeping a room, then shifting to the task and tools of dusting, then pol-

ishing, then arranging, and then repeating this series of shifts for each room. Dishwashing obviously proceeds more efficiently when the collecting task, then the scraping task, then the washing task, then the drying and then the replacing are each continuously maintained. Similarly, in constructing even such simple objects as window screens, it is more effective to do all sawing first, then all planing, then all sandpapering, then all joining, then all screen cutting, then all stretching and tacking, then all finishing and trimming, and finally all painting, than it is to make each screen complete, changing from set to set, task to task, tool to tool and place to place for each case.

This simple principle of the maintenance of set should find application in innumerable types of work. It should scarcely be necessary to point out that any such principle should be applied, not blindly and inflexibly, but always with due regard for the circumstances and for other principles which may be equally important. Thus, in the case of the window screens, it would be a mistake to insist on doing first all screen stretching, then all tacking, since this would involve a complete rehandling of every screen, although the tools employed would be the same in both cases. Moreover, such simple facts as that monotony and lack of variety in one's occupation may make for inattention, mind wandering, accident and ennui, thus incapacitating the worker, cannot be ignored.

Effective Distribution of Effort.—Such principles as that of the effective distribution of work and rest, in such way that the worker may escape the disastrous results of over fatigue and yet not lose the advantages arising from being already "warmed up" and in action, find application in any kind of work, from studying geography to mowing grass. Taylor found that in so simple a task as that of carrying chunks of iron from one place to another there was a definite law covering the ratio of the time the worker should be under load to the time he should be at rest. He found by actual experiment that a man carrying chunks of iron weighing 92 pounds should be under load only 42 per cent of the day, being without load, either returning or resting, for 58 per cent of the time. When workers were placed on such a schedule they were found to load 47 tons each daily, instead of the 12.5 tons which had been the average record when the worker observed no such principle. The individual's inclinations, intuition, traditions and feelings of fatigue were no reliable index of the effectiveness of his work method, and the new method seemed no more difficult nor fatiguing than the old haphazard one.

In some kinds of work the "load" or amount of energy required at each act or moment may be so varied and adjusted to the general laws of work, fatigue and individual difference that personal comfort and effectiveness of effort may both be increased. Thus when the optimum load for such

work as shoveling has been determined, the size of the shovel may be systematically adjusted or varied with the heaviness of the substance being handled, instead of using a traditional shovel and varying the amount lifted in a random way or not at all. By such methods the work of gangs of shovelers has been increased three or four fold, and each man's daily earnings increased, if not proportionately, at least considerably.

Organizing the Path of Movement.—Closely related to this subject of the effective distribution of work and rest is that of the routing of operations. The paths followed by the worker in moving from one part of the plant to another, from materials or storehouse to bench, from bench to tool chest and back, from bench to warerooms, etc., may also play a large part in his working capacity. No better illustration need be given of the importance of a systematic organization of the worker's movements than Christine Frederick's account[1] of the organization of the worker's path in the case of a kitchen. She writes:

I recall a young bride who recently showed me her new kitchen. "Isn't it a beauty?" she exclaimed. It certainly had modern appliances of every kind. But her stove was in a recess of the kitchen at one end. Her pantry was twenty feet away at the opposite end. Every time she wanted to use a frying pan she had to walk twenty feet to get it, and, after using it, she had to walk twenty feet to put it

[1] Christine Frederick, "The New Housekeeping," p. 46.

away. I know blocks and blocks of houses in a city over 100,000 population which are all built that way. When I see such a kitchen I am reminded of the barker I once heard outside of a country circus. "Ladies and gentlemen," he was calling, "come in and see the great African crocodile. It measures 18 feet from the tip of its nose to the tip of its tail, and 18 feet from the tip of its tail to the tip of its nose, making in all, ladies and gentlemen, a grand total of 36 feet." How many women are "making a grand total of thirty-six steps" every time they hang up the egg-beater?

She then gives side by side a diagram of a kitchen "showing badly arranged equipment, which makes confused intersecting chains of steps, in either preparing or clearing away a meal," and also the same kitchen properly routed, so that the steps involved in either process are simple and few.

Time and Motion Study.—The general importance of routing or organization of paths leads naturally to the intensive study of the more simple movements of the worker,—the movements of arms, hands, feet, head and trunk. Under the name of "motion study" such work has received considerable attention from industrial engineers and managers, and represents an elaboration and application of work begun years ago in the psychological laboratory on such problems as reaction time, habit formation, practice, acquisition of skill, fatigue, etc. By recording accurately the separate movements which comprise the worker's activities, discovering useless steps and delays, interferences and faulty coördinations,

a plan of movement is arrived at which is best calculated to accomplish all the work in the quickest possible time and with a minimum of effort. Gilbreth and his co-workers have done extensive work in this field and have perfected many devices for recording even the swiftest, most complicated and delicate movements, such as those of the expert typewriter, the pianist and surgeon. Various special devices have also been constructed whereby the movement paths, both inferior and superior, may be graphically, stereoscopically, by motion pictures or otherwise demonstrated to the worker and thus utilized by him in the perfection of his handicraft.

Sometimes the changes made are not in the path of movement itself but rather in the arrangement of the worker's body, his materials, tools or equipment. Thus in Gilbreth's classical study of bricklaying operations, the changes made were mainly in the disposition of materials and in the routing of the work, but these changes brought up the average number of bricks laid per hour from the traditional standard of 120 to 350 per man, and reduced the number of movements involved in laying a brick from 18 to 4. In almost any workshop, factory, office or home, simple changes in the height of chairs or benches, the elevation of tables, sinks and desks, the position of tools, filing cabinets, drain boards, sinks, etc., show that this type of study of human behavior and the conditions of its effectiveness is both interesting and valuable.

This type of observation and study may be profitably undertaken by anyone interested who is at all familiar with the psychological methods of measuring work. One student of applied psychology found that a few minutes of such observation enabled her to save ten minutes of the half hour usually required in making a cake. Another found herself dressing in half the traditional time; another saved several hours of time each month by routing and reorganizing the processes of bathing and shaving. Two students, studying the distribution of movements in typewriting on an ordinary machine with a given type of keyboard found that, out of 37,356 movements, 21,301 were struck by the less efficient left hand and only 16,055 by the more efficient right hand, thus disclosing an ineffective arrangement of the letters on this particular keyboard. A slight change in the height and slope of the work table enabled girls engaged in sorting and filing records to increase their output by 50 per cent. In another factory a motion study led to the making of several small alterations in the operation and arrangement of the machinery, with the result that seven girls, working eight and one-half hours, were able to accomplish what had previously required thirteen girls working ten hours, a reduction from 130 to 59.5 total hours. The literature of scientific management and efficiency engineering is replete with such instances.

Psychological Reaction of the Worker.—Of equal

importance, though more recent in its development, is the question of the psychological effect of such methods on the worker. Do these methods tend to destroy his spontaneity and individuality and reduce him to an automaton by prescribing for him a routine plan of work? Do they decrease his initiative, surround him with monotony, and overspecialize his activity and training? Or do they release his attention for more profitable activity, enable him to capitalize and to derive the greatest possible advantage from such special aptitudes as he may chance to possess, improve his health, increase his interest and observation, stimulate his own analytic and scientific ability, prevent accident and strain and promote stability, long tenure and years of productivity? In the solution of these questions, as well as in the adaptation and development of the industrial methods which raise them to consciousness, the applied psychologist finds an inviting and valuable field of research.

As a final illustration of the various applications of psychology in the workshop we may instance the influence of the worker's mental condition, attitude, expectation and purpose on the quality and quantity of his work. In a previous chapter the influence of such factors on learning and on the acquisition of skill have been pointed out. In the present connection may be given a concrete instance of the practical importance of these factors in the workshop. In tabulating the census returns, in a very

elaborate manner, it was necessary to use a new machine and a complex series of punching and lettering symbols to correspond to such items as age, sex, color, nationality, occupation, education, language, etc. After a very careful preliminary training and practice, covering some five weeks, in the use of the machinery, studying the schedules, and memorizing the symbols, the operators, who had begun with the express idea that the work was exceedingly difficult, fatiguing and called for exceptional ability and skill, were able to complete, on the average, some 500 cards per day. But this record seemed to call for such feverish effort that protests were made and no further publication of records by way of stimulation was allowed.

After the work was well under way about 200 new clerks were put into one room and scattered through the force already at work. They had no experience with the schedules and knew nothing of the symbols and had never seen the machines. They saw those around them working easily and rapidly, and in three days several of them had done 500, in a week nearly every one, while the general average was rising. There was no longer any question of nervous strain.[2]

In fact one day before the work was over one of these new operators, who had not had the preparatory five weeks of training in mastering the

[2] Quoted by Jastrow in "Fact and Fable in Psychology," from Mrs. May Cole Baker.

schedules and memorizing the symbols, broke the record achievement by completing 2,230 cards.

It is thus demonstrated that an unskilled clerk, with the environment proving the possibility of a task and suggesting its easy accomplishment, can in three days succeed in doing what a skilled clerk, with preliminary acquaintance of five weeks with the symbol to be used could only do after two weeks' practice, and this because the latter, doubtless not a whit inferior in ability, had been led to regard the task as difficult.[3]

[3] *Ibid.*

CHAPTER XIII

PSYCHOLOGY AND THE MARKET

Psychology of the Consumer.—The market exists primarily because the consumer exists, and the refinements of marketing methods depend chiefly on the fact that the consumer must be dealt with as a psychological individual, as well as an organic, economic or political unit. The commodities of the market are there because the consumer has certain needs, values, habits or desires which those commodities may satisfy. The original needs of human beings, the requirements of food, shelter, clothing and defense are by no means his sole wants. Equally urgent are his much more distinctively human demands for comfort, cleanliness, recreation, display, decoration and society. Still less instinctive and in large degree educationally and socially acquired are his desires for tools, knowledge, power, prestige, insurance, property, sport and art.

The activities of the manufacturer must either be directed solely by the existing needs of the consumer or else he must, by some art of compulsion or education, modify the prevailing wants or stimulate novel demands. Under a competitive system

of supplying the market it is still further necessary or expedient to take into account the established habits of seeking satisfaction for these needs, to adapt the commodity, the container, the price or the sales method to these habits, or to redirect and educate these consumer habits into specific forms and directions. All this involves the consideration of the consumer from a psychological point of view.

In serious discussions of manufacturing and marketing problems the psychology of the consumer is always in the foreground, and such phrases as "consumer defenses," "buying habits," "effective appeal," "the sales attack," etc., form part of the modern business man's working vocabulary. In recent books on the modern methods of marketing we find explicit recognition given to "the consumer's defenses," partial enumeration and illustration of them, and suggestions as to various devices, procedures and tactics for "breaking down" or evading these defenses. Conspicuous among these resistances are the limitation of spending power by earning capacity, the strength of the savings instinct, the standard of living, social expectation of expenditure, the habit of paying conventional or particular prices for certain commodities, habits of buying particular things at particular places, in particular amounts or forms, etc. Thus the manufacture and sale of automobiles and talking machines encounter the limitation of spending power and the sav-

ings instinct. The marketing of fashionable apparel, travel, and education encounters standards of living that must be catered to or raised. The sale of collars, hats, patent medicines, toilet articles and household wares that do not fall into a conventional price category must reckon with a definite psychological resistance. An attempt to market bread through the stationer or soap through the laundry would find established buying habits strongly entrenched. The introduction of safety razors, while it promised abundant satisfaction of existing needs, is still resisted by the shaving habits of many prosperous consumers. Paper dishes, however sanitary, economical and expeditious, do not find ready adoption. Mail order methods meet with definite and familiar psychological resistance on the part of many members of a local community.

In the same way the more general and extra-commercial tendencies of human nature go far toward determining the form and pattern of various marketing institutions. A neat example of such a tendency is that ancient and universal human demand for a concrete symbol of any general object or abstract service, institution or principle. Political parties cannot exist abstractly,—each must have its name, its slogan, its totemistic symbol of beast, bird or fish. Colleges must be known by their seals or colors, states by their flags or hymns, societies by their badges, professions by their sartorial or tonsorial styles, and the principle of Justice, the con-

dition of Peace, the concept of Power, must each have its concrete sign and symbol. In much the same way the early artisans and shopkeepers soon learned the advantages of trade symbols,—barbers' poles, butchers' horns, golden balls, colored bottles, wooden Indians, etc.

For similar reasons the modern manufacturer, jobber and dealer find that complicated psychological and social demands require that crackers, eggs, tea, clothespins, chewing gum, automobiles, pianos, furniture, insurance companies and international enterprises must each and all be christened, marked with a recognizable symbol, encased in a distinctive package, or indicated by special devices in the form of brand, color, marking, emblem or stationery. Says Graham Wallas:

> The actual tea leaves in the world are as varied and unstable as the actual political opinions of mankind. Every leaf in every tea garden is different from every other leaf, and a week of damp weather may change the whole stock in any warehouse. What therefore should the advertiser do to create a commercial "entity," a "tea" which men can think and feel about?—Nowadays—he would choose some term, say "Paramatta Tea," which would produce in most men a vague suggestion of the tropical East, combined with the subconscious memory of a geography lesson on Australia. He would then proceed to create in connection with the word an automatic picture-image having previous emotional associations of its own. By the time that a hundred thousand pounds had been cleverly spent, no one in England would be able to see the word "Paramatta" on a parcel without a vague impulse to buy, founded on a

day-dream recollection of his grandmother, or of the British fleet, or of a pretty young English matron, or any other subject that the advertiser had chosen for its association with the emotions of trust and affection.[1]

In recent years the manufacturer has found the methods of the psychological laboratory of distinct service in ascertaining beforehand the relative effectiveness, impressiveness, interest and attention value of various packages, slogans, emblems, and trade-marks. In modern scientific business the selection of any such marketing aid takes place only after preliminary measurements of these thoroughly psychological properties and attributes. Thus in a recent case the name, the packages and the slogan of a new commodity were all selected by psychological measurement, even to such minute details as typography, color, shape, and position of details. Only when all these factors had been determined by actual experiments on prospective consumers was the commodity placed on the market.

The multiplication of these symbolic devices inevitably leads to frequent resemblance and confusion among them, and then arise questions of infringement which again involve problems which are psychological in their nature.

An interesting illustration of this field of applied psychology is to be found in the investigations re-

[1] Graham Wallas, "Human Nature in Politics."

ported by Paynter.[2] Through a carefully planned technique, this investigator arranged situations in which observers were required to indicate whether or not the members of a series of trade-names, presented one at a time, were identical with names which had been seen on a previous occasion. In some cases the names were really identical while in other cases similar names, imitations or infringements, were substituted for the originals. The degree of confusion which the names occasioned was measured in terms of the number of cases in which the substitutes were mistaken for the originals. Some of the pairs represented cases on which legal decisions had already been passed, ranking them either as infringements or as non-infringements. The direction of the legal decisions may thus be compared with the actual tendency to confusion shown under the experimental conditions. The following table gives some of the pairs of trade-names, the per cent of confusion in each case, and the direction of the legal decision.

Original	Imitation	Per Cent Confusion	Legal Decision
Sozodont	Kalodont	28	Non-infringement
Nox-all	Non-X-Ell	28	Infringement
Club	Chancellor Club	35	Infringement
Bestyette	Veribest	35	Non-infringement

[2] A Psychological Study of Confusion Between Word Trade-Marks, Richard H. Paynter, in *Bulletin of United States Trade-Mark Association,* May, 1915.

Original	Imitation	Per Cent Confusion	Legal Decision
Mother's	Grand-Ma's	38	Non-infringement
Au-to-do	Autola	40	Infringement
Peptenzyme	Pinozyme	43	Non-infringement
Green River	Green Ribbon	50	Infringement
Ceresota	Cressota	63	Infringement

Referring to these and similar results Paynter[3] remarks:

If the legal decisions were all accurate, the non-infringements would show lower degrees of confusion than the infringements. That the decisions are not all accurate may be seen from the overlapping of the scores of the infringements and non-infringements. According to the per cent of confusion only two infringements are more confusing than the most confusing of the non-infringements.—The fact that the difference of the averages of the infringements and non-infringements is so small compared to the great differences within the groups of infringements and non-infringements shows the results of judicial decisions in this field to be quite unreliable.—It would manifestly be a great saving in time, money and energy to determine the degree of likelihood of confusion between word trade-marks by psychological experiment. The writer is devising a scale of similarity on which will appear actual word trade-marks and imitations thereof ranging from those showing very little confusion to those which show absolute confusion. Each trade-mark will have two ratings, one indicating the percentage of confusion and the other the grade of the marks with respect to relative confusion. If

[3] Those interested in further developments of this type of work should consult Paynter's monograph, published in the *Archives of Psychology,* entitled, "A Psychological Study of Trade-Mark Infringements."

a standard degree of confusion constituting infringement could be agreed upon, the average position which a number of competent individuals independently assigned to the mark and the imitation involved in a specific case would determine whether the imitation was an infringement or a non-infringement, according to whether it fell above or below the degree of confusion agreed upon as the standard.

In all the foregoing discussion the employment of psychological attitude, knowledge and technique has throughout been attributed to the manufacturer or the distributer in his attack upon the consumer. The consumer himself has shown little demand for the development of a science of resistance to the advances of the salesman and advertiser, although it has often been suggested that he would profit by such instruction. Perhaps it would be sufficient if the consumer would take a psychological attitude toward what is happening to him, taking stock on the one hand of his various defenses, comprehending the nature of the weapons of the market place, and especially familiarizing himself with that extraordinary influence which the advertising writer knows as "the power of print." "It is written" was once the final seal of truth and the guide to conscience and conduct. To have "seen it in a book" or "read it in the paper," or to have absorbed it from a thousand bill boards, posters, car cards and circulars is still to the average consumer the final test of expedience and determiner of desire and value.

The Psychology of Advertising.—Next to educa-

tion, the field of advertising has received more widespread and detailed attention from the applied psychologist than has any other practical enterprise. As early as 1750, Addison and Johnson wrote essays in *The Tatler, The Idler* and *The Spectator,* pointing out the psychological interest of the advertisements then appearing in the public prints. It was pointed out that the advertisement not only relied on certain mental principles but also afforded glimpses of human nature which the social philosopher could not afford to ignore. A recent book on "The Advertisements of the Spectator" discusses in detail the social and historical value of such documents as advertisements, as well as their general human interest.

Certain it is that he who traces the history of advertising from its most primitive forms in the courtship of animals, the display of vendable prowess and skill in joust and tournament, the development of ceremony, heraldry, and dress, to the subtle forms of personal publicity adopted by the modern statesman, clergyman, or *débutante,* it seems to constitute no mean proportion of the activities of individual, family and social life. Or on its more commercial side, as one traces the methods and technique of marketing from the display of wares on a blanket by the highway, the formation of fairs and bazaars, the development and organization of public and private criers, the introduction of trade and professional symbols, through the invention of printing,

the circulation of placards and posters, the construction of "news books" and "intelligencers," the rise of the periodic magazine and newspaper, to the elaborate systems, devices and implements of modern advertising, one comes to feel that the history of advertising would in itself be a valuable compendium of the economic, social, educational and scientific progress of mankind. Each of these steps arose on the basis of a definite psychological and social background, and each in turn exerted a definite psychological and social influence.

But the explicit introduction of psychological technique into the now complex science of advertising belongs to very recent years. In 1900 Harlow Gale published a series of brief articles, reporting the results of laboratory experiments on the legibility, attention value and interest of printed advertisements. He even went so far as to break up the complete advertisement and use its elements in the laboratory in the place of the lights, sounds, rectangles, weights and other paraphernalia with which the psychologist had heretofore experimented. Thus he suggested the possibility of measuring the importance and value for practical purposes of such factors as illustration (relevant and irrelevant), text, size of type, content of the argument, etc.

In 1903 Scott published under the title "The Theory of Advertising" a very suggestive exposition of the application in the art of advertising, of the laws of memory, association, feeling, choice, etc.

He also began the use of questionnaire methods in the investigation of advertising problems; conducted various experimental inquiries into such factors as the size of advertisements, the reading habits of the public, etc.; and in 1908 issued a second book on "The Psychology of Advertising," now familiar to every student of the subject.

In 1909 Hollingworth began a series of investigations in coöperation with the Advertising Men's League of New York, and after several years of such round-table labor in the analysis, experimental measurement and psychological interpretation of the media, varieties, tasks, technique and principles of advertising, the results were embodied in his book on "Advertising and Selling."

Since this time similar and supplementary studies and volumes have been presented by Strong, Starch, Breitwieser, Brown, Adams and others. Courses of instruction, research fellowships, lectures and laboratory work on the psychology of advertising have been introduced into a score of schools, colleges and universities, and dissertations for the highest academic degrees have been presented in this field. Along with the artist, writer, printer, industrial investigator, statistician and technical advertising expert, the psychologist may be found working in the modern advertising agency or in the publicity and promotion department of large manufacturing concerns.

To present in any detail the numerous ways in which the attitude, content or technique of psychol-

ogy may be applied in the field of advertising would take us far beyond the limits of this chapter. It must suffice to indicate by an outline arrangement the leading features of these applications as they are now to be found. The inquiring reader may be referred to the many available manuals for more detailed account of these interesting points of contact between psychology and the market.

Outline Suggesting the Varied Applications of Psychology in Advertising

I.—APPLYING PSYCHOLOGICAL ATTITUDE

1.—In analysis of tasks and psychological basis of sales appeal.

2.—Analysis of types and varieties of sales appeal.

3.—Analysis of special devices used in each task and type.

4.—Analysis of returns and results of campaigns.

II.—APPLYING PSYCHOLOGICAL CONTENT

1.—To appropriate selection of media and types of appeal.

2.—Adjustment of appeal to audience, purpose, commodity.

3.—Laws of attention, perception, interest, memory, association, feeling, emotion, suggestion, choice, action, in framing the appeal.

4.—Principles of feeling and laws of esthetics, in the arrangement, design, display, ornament and lay-out.

5.—Laws of reading and perception, for the printer, typographer and illustrator.

III.—APPLYING PSYCHOLOGICAL TECHNIQUE

1.—Recognition method, tachistoscope, etc., in the measurement of attention value, legibility, etc.

2.—Methods of impression, in determining the effectiveness of colors, design, arrangement of advertisement, the atmosphere of packages, names, etc.

3.—Method of relative position, in measurement of the persuasiveness of appeals, reader reactions to copy, consumer preferences for slogans, names, packages, illustrations, commodities, etc.

4.—Statistical technique of mental and social measurement in field investigation, analysis of circulations, comparison of media, and in the derivation of scales and tables of measurement.

5.—Genetic method in studying the evolution of devices, historical changes and tendencies.

The Psychology of Salesmanship.—The materials of advertising lend themselves with special readiness to the analysis and experimental methods of the laboratory. Printed appeals may be collected, presented, handled, dissected, preserved and studied over long periods of time and under constant or known conditions. But the oral appeal of the personal salesman offers problems of far greater complexity. From its very nature the sales talk represents a continuous process of which the printed advertisement is but a cross section. Once the advertisement is presented its influence is determined once for all, and it is either relatively successful or relatively futile. But the oral salesman, working at

close range and face to face with his customer, may choose his appeal, vary it, repeat it or supplement it according to the particular idiosyncrasy of the customer and according to the time and circumstance of the interview.

The oral sales talk is to the printed advertisement what the motion picture film is to the simple lantern slide, the drama to the tableau, or the kaleidoscope to the frozen frost pattern. The sales talk is a whole advertising campaign condensed into a few moments and adjusted and adapted to the present responses of the audience. It is not restricted to its verbal dress, but is reënforced, emphasized, or otherwise modified by the personality of the salesman, his appearance, voice, dress, bearing, expression, intonation and gesture. Once it is finished it may never occur again in precisely the same form or under precisely the same conditions.

The advertisement on the other hand in addition to the frailties already indicated, must in the nature of its work be addressed not to a single individual nor in general even to individuals of the same type and interest under circumstances which are even momentarily common. It must address itself within certain limits to the average individual or standard person of a group, an individual who, as thus defined, has no concrete existence.

For these and other reasons, while much reference has been made to the psychology of salesmanship, there cannot be said to exist any body of facts,

principles or methods in any way comparable to the established laws, results, and technique of the psychology of advertising. There is, to be sure, reason to believe that the principles of successful salesmanship are no different from those underlying the successful advertisement, sales letter, or window display. But their operation in any given instance is obviously much more obscure and complex.

Consequently the psychology of salesmanship, when it does not degenerate into a collection of bromidic maxims or a brisk and stimulating bit of "ginger talk," consists for the most part of the general facts of human nature, and is relatively restricted therefore to what we have called the "content" of psychology as distinguished from its attitude and technique.

The salesman, to be sure, no longer looks upon the act of selling as a single event. He is accustomed in his own preparation, in sales instruction, and to greater or less degree in actual performance, to analyze the process into various elements, steps or stages, such as preparation, approach, presentation, argument, closing the deal, etc. And in so far as psychological measurement is able to specify the relative strength or persuasiveness of various sales points or bases of appeal, he may with profit utilize the results of such methods. For the most part, however, as matters now stand, the salesman can best profit from psychology by familiarizing himself in an expert way with the original and acquired

tendencies of human beings, the mechanisms of conduct, thought and feeling, the range of individual differences in interest, values, motive and temperament, the general lore and doctrine of expression, emotion, belief and reflection, and especially with the laws of cogent reasoning, the fallacies of argument, and the instinctive promptings underlying such factors as suggestion, resistance, conflict and decision.

An interesting venture in the applied psychology of our own day looks forward to the possibility of diagnosing, by the various means of mental measurement, the personal characteristics which combine to characterize the successful salesman. It further contemplates the possibility of determining to what degree such particular qualities or aptitudes, if such there be, are original and temperamental traits, and to what degree they may be acquired by adequate effort and practice or communicated by competent instruction. In this type of research into the vocational psychology of salesmanship may perhaps be found in time the field of application of psychological analysis and experimental method, as distinguished from the more cultural application of psychological knowledge.

CHAPTER XIV

PSYCHOLOGY AND THE LAW

The work of the law arises out of the attempt to control conduct and this task at once involves the whole range of such topics as incentive, impulse, choice, action, value, thought and feeling, the whole arc of appeal and response, the intensive study of which constitutes the problem of psychology. Moreover, in its evidential, administrative and judicial aspects, the law implies the acquisition, evaluation and interpretation of the testimony of witnesses and the assignment of more or less specific responsibility for acts or for failures to act. All of these matters again are, from a point of view other than that of control, subject matter of psychological study. It is apparent then that the general importance of psychology in legal, criminal and penological affairs cannot be presented in a comprehensive way in a single chapter. It will be possible only to point out and illustrate four chief directions in which psychology has at least endeavored to be of definite service to the formulators and administrators of the law.

These four directions may be conveniently designated,—The Accumulation of Evidence, The Evaluation of Testimony, The Determination of Responsibility and The Adaptation of Corrective Measures.

The Accumulation of Evidence.—Two illustrations will indicate the nature of the efforts made in this direction. The first is the "free association method," that form of psycho-analysis which is employed in the so-called "Tatbestandsdiagnostik" experiments. This experiment has come to be a favorite form of demonstration in many laboratories, and in one of its forms is usually conducted in the following way. Three members of the class are sent out of the room in charge of an assistant, who selects one of the three to play the rôle of "criminal" in the test which is to follow. This person is put through some experience in which the two remaining students do not participate,—is shown a picture, read a story, instructed to perform some more or less exciting act, etc. The three students are then brought into the class room one at a time and required to give free association responses, as quickly as possible, to a selected list of stimulus words. This list contains some words which are called "critical." They are words closely related to the experience through which one of the three students has just passed. The association responses are recorded and in each case the time is measured which has elapsed between the response and the presentation of the stimulus word. The

series is then gone through again, in reverse order, and the original reactions called for. In this manner all three of the students are examined and the instructor or the class judges, on the basis of the test results, which of the three "suspects" is "guilty,"—which one possesses the special knowledge or experiences the special emotions produced by this knowledge.

The indications that the "guilty" individual will be likely to give in such an examination are:

1.—Significant reactions to critical words.

2.—Retarded reactions to critical words or to indifferent words following closely upon them.

3.—Changed reactions to critical words when the reverse series is given.

4.—Undue number of stereotyped or reverberating reactions.

When skillfully conducted the experiment in this form seldom fails. The procedure has been suggested as a means of indirectly securing evidence which the direct interrogatory, cross examination, or "third degree" might fail to reveal, and the application of the method in police and court procedure has been enthusiastically advocated by some psychologists. The writer has seen the method used in the case of a suspected thief, whose guilt was not only satisfactorily demonstrated but whose actions subsequent to the theft were also partially disclosed. Confronted with the evidence of the experimental results, the man confessed, and told a

story of the crime which confirmed the indications of the experiment. Jung, Münsterberg, Peterson, Scripture, Crane and others have used the method with varying degrees of success. Its practical merits and ultimate possibilities are still open to discussion. It should, however, be noted that in the form here described the problem is only that of determining which of a number of individuals is guilty, whereas the practical problem, that of determining the guilt or innocence of a given individual is a much more difficult matter.

A second method of securing evidence may be briefly illustrated in connection with such an experiment as that just described. Psycho-analysis proceeds on the assumption that emotionally toned experiences in one way or another determine the flow of ideas. This second method, the method of expression, as it is called in psychology, proceeds on the assumption that emotions are attended by characteristic motor reactions, among which are included gross external muscular innervations, changes in respiration and heart beat, vascular adaptations and variations in the secretion of various glands, such as the salivary or the sweat glands. By the use of appropriate recording apparatus, sphygmographs, pneumographs, plethysmographs, galvanometers, etc., the organic changes which occur during such an examination as that of the preceding experiment may be registered, and these may offer significant suggestions. Thus Benussi reports that the

truth or falsity of an oral statement can be detected by noting the ratio of length of inhalation to length of exhalation before and after the statement. In the case of what has come to be known as the psycho-galvanic reflex, changes in the secretion of the sweat glands incident to the arousal of an emotion may be indirectly observed through the use of the galvanometer. But up to the present time the method of expression has been able only to indicate that some emotion or excitement is present. The character of the emotion, its basis and deep-seated significance, cannot be inferred from the records. As for both these methods of securing indirect evidence, whether or not they may constitute a genuine contribution to legal and criminal procedure remains for their future elaboration and application to determine.

The Evaluation of Testimony.—Innumerable problems arise under this heading, chiefly because the testimony of witnesses in the courts is usually based on "incidental memory," the bystander at an event having observed it not with the intention of accurately reporting the details, but more often with attention fixed mainly on the dramatic aspects of the episode. Even when one sets out with the deliberate intention of observing, remembering and reporting what takes place before him, innumerable sources of error disqualify much of the testimony. When the observation is incidental these sources of error are multiplied beyond any possibility of systematic description. Let the reader at this moment

write down, without present observation, the number of buttons on his coat, the character of the weather one week ago today, the number of windows in a particular class room, the contents and arrangement of a certain room visited yesterday, the number and color of the books on some familiar shelf, the way in which the sixth hour is indicated on the dial of his watch, the color of the eyes or of the cravat of the last person with whom he talked, or the size, shape and number of the columns before some public building. He will at once realize that the testimony of bystanders with respect to any detail except the major topic of attention is indeed unreliable.

The ancients were sufficiently interested in this matter to enumerate various illusions of perception to which observers are liable. Especially during the past 100 years there have appeared from the hands of jurists, lawyers, and psychologists a great variety of treatises, discussions and reports bearing on what Bentham in 1800 called "the psychological causes of correctness and completeness in testimony." In fact the nature of perception, its tendencies, determinants, characteristics, accuracy and individuality bulks large in every textbook of psychology and in every consideration of "judicial evidence." The newspaper account of almost any trial in which sincere witnesses independently report their version of an event will disclose in a most instructive way the importance to judge, lawyer and jury of a knowl-

edge of the psychology of attention, perception, memory, imagination, suggestion and belief.

In recent years numerous investigations, initially suggested by the work of Cattell, Binet, Stern and others, have endeavored to go beyond the general exposition of the psychological tendencies involved, and to secure precise measurement of them. Setting out from the well known fact that observation, memory and report are all liable to error,—error on the part of the observer, error in the processes of recollection and memory, difficulties in the process of communication, and errors of interpretation on the part of the listener, they have attempted to determine by exact experimental methods the nature, degree and causes of these errors and their dependence on such factors as individual difference, age, sex, practice, intelligence, time interval, mode of report, degree of suggestion, suggestive question, etc.

Thus it has long been recognized that the way in which a question is asked has an important influence on the actual correctness of the answers made to it. By various details of its construction the question may convey implications, suggest replies, or eliminate alternatives. In legal procedure the "leading question" has long been regarded as a possible source of fallacious testimony, but not until recently has there been an attempt to clearly discriminate the various types and degrees of leading question from each other. Recently, in France, Germany and England, experiments have been made in order

to measure the reliability of answers as conditioned by the form of question.

Muscio's investigation may be referred to by way of illustration. Using moving pictures as material for observation, he asked questions, all of them of a leading character, and tried to measure the influence of different question forms. He used eight different question forms, as given in the following table. Careful examination of the questions as here given will disclose their varying degrees of suggestiveness. The figures indicating the type of answer indicate the per cent of correct, wrong, and uncertain replies, when the results of several experiments, in which all the questions in the table related to actual occurrences, were combined.

Form of Question	Times Asked	Right	Wrong	Uncertain
a—Did you see a ——?	171	12	2	81
b—Did you see the ——?	95	31	7	62
c—Didn't you see a ——?	102	23	3	74
d—Didn't you see the ——?	81	16	1	83
e—Was there a ——?	173	32	25	43
f—Wasn't there a ——?	167	38	28	34
g—Was the (K) m or n—?	137	36	28	36
h—Was the (K) m ——?	136	23	44	33

The results were found to vary with a number of circumstances which cannot be considered here. In general, however, the following conclusions were

suggested. By using the definite article (the) instead of the indefinite (a) the suggestiveness, caution and reliability were all decreased. Introducing the negative (not) into the question decreased caution and reliability and increased suggestiveness. By asking whether certain things were present or occurred, rather than whether they were seen or heard, suggestiveness, caution and reliability were all decreased. By asking concerning the presence or occurrence and also including the negative, suggestiveness and caution were decreased. Including both the definite article and the negative gave more complicated results. The so-called "implicative" question, "Was the (K) m?" was found to be "lower than all the other question forms investigated, for suggestiveness, caution, and reliability." The "incomplete disjunctive" form, "Was the (K) m or n?" was found to possess "a relatively high suggestiveness, a relatively low caution, and a relatively low reliability." In general and with certain qualifications the investigator concluded that the most reliable form of question was that which related to the actual seeing or hearing of an item, using neither the negative nor the definite article.[1]

As representative of another type of investigation in this field the experiments of Breukink [2] will serve.

[1] Bernard Muscio, "The Influence of the Form of a Question," *British Journal of Psychology,* Sept., 1916.

[2] "Ueber die Erziebarkeit der Aussage," *Zeitschrift für Angewandte Psychologie,* Band III, Heft. 1 and 2, June, 1909, 32-88.

He was especially interested in the influence of practice on the fidelity of testimony. He used three different pictures on occasions a week apart, with the same group of observers. The reports were always written, the first narrative being supplemented by a series of questions. He found that if the individual's report was divided into sections, the earlier parts were more reliable than the later parts, showing that the items first coming to mind were more likely to be correctly reported. Reliability also increased with practice, the third picture being more reliably reported than the second, and the second than the first. This increase was especially pronounced in the interrogatory and in the ability to resist suggestive questions. Practice also increased the reliability of oath. He found that his educated subjects mentioned two or three times as many items as the uneducated, and the practice effects were more conspicuous with the educated group than with the uneducated. The uneducated would take oath to three times as many answers to suggestive questions as would the educated. No consistent sex differences were found in fidelity of report, except that the women were found to be more reliable than the men in their testimony concerning colors.

Special journals have been founded in which such reports may be recorded, and the accumulated literature in this field is so considerable that no brief summary can do justice to its range and practical sug-

gestiveness.[3] The chief problems for the immediate future lie in the correlation of these experimental results with the necessities of practical life and in the suitable adaptation of the methods and of the various coefficients of measurement to the requirements and purposes of court procedure.

Determination of Responsibility.—This third topic may be very briefly presented. That type of psychology which is interested in criminal natures, perversions, exaggerated instincts, insanities, the relation between original nature and environment in the production of criminal tendencies, the curve of distribution of mental and moral traits, the problems of the inheritance of nervous dispositions, eugenics, the detection and treatment of feeble-mindedness, the behavior of mobs, the sources and demands of social control, and a variety of kindred topics, is coming to have more and more importance in modern life, and must work hand in hand with legal and criminal institutions and investigators. It is at present impossible to say in which direction the contribution will be greater.

No better example can be cited of the usefulness of psychology in the determination of responsibility than the work of the clinical psychologists with cases brought to the Juvenile Courts. In one instance 100 cases, sufficiently serious to warrant detention,

[3] Interested readers will find a summary of the experimental methods and results in the chapter on "Fidelity of Report," in Whipple's "Manual of Mental and Physical Tests," Vol. II.

were examined by means of standard scales for the measurement of intellectual age. The misdemeanors had been various,—such as stealing, immorality, incorrigibility, etc. The ninety-seventh child tested was found to be normal, all the rest of the hundred being shown to be mentally defective. Only thirty-four were less than four years backward, and this is suggested as the extreme limit for possible responsibility and normality. Sixty-six cases were feeble-minded, from four to eight years backward. The average chronological age of the group of one hundred was 13.8 years; the average mental age, according to the tests, was 9.2 years.

In another case fifty-six inmates of a girls' reformatory were similarly tested. The ages ranged from 14 to 20, averaging 18.5. According to the tests for intellectual age, they measured as follows:

Number	Intellectual Age	Chronological Age
1	8	An average of 18.5 years.
12	9	
14	10	
14	11	
11	12	
4	13	

Goddard, the investigator reporting these results, remarks in discussing their significance:

As the tests for 13 years have been demonstrated to be much more difficult than that age would indicate, we may

say that four out of the fifty-six are not feeble-minded, as we usually define feeble-mindedness. The rest are clearly mental defectives.

The importance of this type of investigation for the practical determination of responsibility under the law is at once obvious. The results, the development and perfection of the tests, and the increased possibility of their application by trained psychologists should be of great interest to the legislator and magistrate as well as to society at large. Responsibility is a mental function, not a physical one, and its determination a psychological, not a medical task. So important is the psychological status and condition, the mental health or disease of the individual accused or convicted of a criminal act, that no just verdict of his degree of responsibility, no intelligent recommendation for his immediate care, and no socially motivated prescription for his ultimate treatment or disposal can be made except on the basis of a thorough and scientifically conceived mental examination. So widely has this recognition now become established that no criminal or police court, no department of justice, charities or correction, no modern reformatory, prison or similar institution for the handling of human derelicts or malefactors is now considered adequately equipped or manned unless a psychological laboratory is part of its organization and a clinical psychologist a member of its staff, or unless a psychological clinic on some other foundation is readily accessible.

Here as in so many other places, it may be pointed out that the chief actual contribution on the part of psychology is methodological in character. It consists principally in the development, standardization and application of methods of measuring mental traits and capacities.

The Adaptation of Corrective Measures.—The foregoing problem of the determination of responsibility is closely related to the final one in this field,—that of the adaptation of corrective measures. In so far as the criminal is found to be intellectually deficient, the corrective or remedial or protective social measures must be adapted to the degree of his defect. Capital punishment, torture, prolonged solitary confinement, hard labor, moral suasion and educational efforts will none of them avail to change the mental status and the irresponsibility of the defective. Nor can they render more moral the quality of his acts, except in so far as they serve to remove him from social situations, or by segregation or sterilization, to prevent the propagation of his kind. The sooner this is recognized the more quickly will the medieval attitude disappear from our penal administration.

In so far as the malefactor is mentally sick, nervously degenerate or psychologically maladjusted to the conditions of social life, the individualization of corrective measures must keep pace with the individualization of pedagogy and of industry and management. In so far as the criminal act issues not

from intellectual defect, instability or abnormality and the criminal represents one whose instinctive propensities, moral restraints and impulses and social reactions are more or less independently vicious or refractory, his treatment also involves problems of a psychological character, except in so far as it represents merely the reaction of revenge or follows the simple ameliorative policy of elimination.

What are the possibilities of modifying human nature by education, example, or other superinduced processes? What is the relative efficacy of reward and punishment, the relative strength of the various instinctive tendencies and of the various proposed deterrents of crime? Which is the strongest deterrent to criminal conduct on the part of the intellectually normal,—the threat of punishment of great severity or magnitude, under conditions of complaint and prosecution which yield a very small percentage of detections and convictions; or, on the other hand, the prospect of punishment, relatively small in magnitude or severity, but under conditions of complaint and prosecution which make detection and conviction extremely probable? Which is the more effective deterrent, a seldom inflicted penalty of life imprisonment or the inevitability of a day in jail? All these questions may be legitimately propounded to psychology, and whatever answer psychology may be able to offer, either now or in the future, will constitute genuine contribution.

The following experiment will suggest some of the ways in which a psychological study of questions of this type may be approached. The experiment itself is but a tentative one, and the results, even for the circumstances indicated, are of a very preliminary character. They suggest, however, the possibility of submitting to experimental inquiry a variety of related problems which are usually approached only through vague interpretation of ambiguous historical results or through biased opinions based on incidental and uncontrolled individual experience.

Instructions

Imagine yourself to be on the point of committing some act which is socially and legally regarded as a crime, but which you are determined to perform because of the intense personal satisfaction it will bring you. The only deterrents are the chance of detection and conviction, the magnitude of punishment, and the social stigma incurred.

Assume that the penalty in all the different states is a period of imprisonment, which is, however, considerably different in amount in the different states, and that some states are more or less lax in their prosecution of the given offense, while others are exceedingly stringent in their methods of detection and conviction.

Suppose that the nature of the crime permits its

commission in any one of these several states, with equal ease and facility so far as you are concerned. Which of these states would you choose first as the place in which you would commit the crime? If you could not select this state, for unavoidable reason, which would be your next choice? Place the ten states in an order of merit on this basis,—placing first the one you would select first, second the one you would next choose, and so on, until the state in which you would be least likely to commit the crime is at the bottom of the list.

Kansas.—Imprisonment for life. Almost absolute certainty of escape. Only 10 cases out of every 1,000 are detected and convicted.

Idaho.—16 years imprisonment. Chances enormously in favor of escape. Only 30 cases out of every 1,000 are detected and convicted.

Montana.—8 years imprisonment. Chances of escape very high. Only 60 cases out of every 1,000 are detected and convicted.

Wyoming.—4 years imprisonment. Abundant chances of escape. Only 120 out of 1,000 cases are detected and convicted.

Arizona.—2 years imprisonment. Considerable chance of escape. Only 250 out of every 1,000 cases are detected and convicted.

Utah.—1 year imprisonment. Chances of escape and punishment are even. 500 out of every 1,000 cases are detected and convicted.

Colorado.—6 months imprisonment. Fair possi-

bilities of escape. 660 out of every 1,000 cases are detected and convicted.

Oregon.—3 months imprisonment. Slight possibility of escape. 750 out of every 1,000 cases are detected and convicted.

Nevada.—1 month imprisonment. Bare possibility of escape. 900 out of every 1,000 cases are detected and convicted.

Arkansas.—10 days imprisonment. Absolute certainty of punishment. Not a single case escapes detection and conviction.

It will have been observed that in a general way the certainty of conviction increases as the magnitude of the penalty decreases. The reader should perform the experiment, making his own arrangement of the various alternatives and recording them, before reading further. The results which are about to be given should not be allowed to influence his personal reactions.

The following table of results shows the way in which fifty college students (twenty-five men and twenty-five women) arranged the various situations. In the column on the left are given the various combinations of magnitude of penalty and certainty of conviction. Along the horizontal headline are indicated the various possible positions, ranging from 1 to 10. For a situation to be placed under 10 would mean that the particular combination represented was felt to constitute the strongest deterrent in the series, the strength of deterrence decreasing from

10 to 1. The figures in the various columns indicate the per cent of all the observers who placed the given situation at the point indicated. Thus in the case of the one year penalty, 10 per cent placed it in first place, 8 per cent in second place, 10 per cent in third, 14 per cent in fourth, 24 per cent in fifth, 28 per cent in sixth, 2 per cent each in seventh, eighth and ninth, and none in tenth.

TABLE OF RESULTS

Penalty	Distribution of Judgments									
	1	2	3	4	5	6	7	8	9	10
10 Days 1000 certain.	16	2	6	6	18	14	4	4	12	18
1 month 900 certain..	8	26	4	8	4	8	6	10	24	2
3 months 750 certain..	2	6	30	10	6	10	6	26	2	2
6 months 660 certain..	8	14	10	22	16	0	28	2	0	0
1 year 500 certain..	10	8	10	14	24	28	2	2	2	0
2 years 250 certain..	8	4	12	8	32	28	0	0	2	6
4 years 120 certain..	6	12	4	24	8	6	32	4	4	0
8 years 60 certain...	8	6	18	2	6	8	8	42	2	0
16 years 30 certain...	1	18	2	2	2	8	10	4	46	2
Life 10 certain...	16	4	2	4	2	4	2	2	6	58

In general these fifty people are seen to be made up of two different groups. The small penalties, with high certainties, tend to be placed more often either very high or very low. The larger the penalty and smaller the certainty the more the situation tends to be shifted toward the middle of the range, until the medium penalties (1 and 2 years) are reached. When this medium point is passed the lines divide again, and the larger numbers occur closer and closer to the extreme positions.

Now if the various situations were equally deterrent, we might have expected the same distribution of positions in all cases. If for all members of the group the larger penalties and the larger certainties were more deterrent we might have expected a single line, shifting from one extreme toward the center, then back again. If only penalty or only certainty were the crucial determinant, we might have expected one line of plurality choices, marching either one or the other way across the table.

But none of these results occurs. Instead, there is one group of people for whom the penalty is the determining factor and another for whom the certainty is the chief deterrent. For both groups the average penalties and average certainties have only average deterrent strength. One group is inclined to take the large chances of escape, risking the large penalty. The other group shows no inclination to gamble, preferring to accept the high probability of a small penalty. What individuals comprise these

two groups the table does not show. The reader who may suggest that the men make up one group and the women the other is, however, in the wrong. The men and women react in the same way, and both show the division into two rather distinct groups, with small numbers of individuals occupying the gaps between.

If each time a situation is placed in 10th, 9th, 8th, 7th, etc., position it be credited with 10, 9, 8, 7, etc., points respectively, and the total points computed for each situation, the following values result. The larger the score the greater will be the judged deterrent effect on the total group of observers.

Situation		Score	Order of Strength
10 days,	1000 certain	292	3
1 month,	900 certain	265	5
3 months,	750 certain	261	6
6 months,	660 certain	223	10
1 year,	500 certain	224	9
2 years,	250 certain	244	8
4 years,	120 certain	253	7
8 years,	60 certain	285	4
16 years,	30 certain	331	2
Life,	10 certain	372	1

These results show that the extremes, either of penalty or of certainty, are judged to have the stronger deterrent effect on the group as a whole, the average degrees of each being relatively weak.

Penalties of 8 years or more, even with high probabilities of escape, are definitely judged more deterrent than penalties of 3 months or less, with almost absolute certainty of conviction.

No one realizes more than the one who planned and conducted this little investigation the numerous difficulties, complications, objections and sources of error which beset such inquiries in legal and criminal psychology. These need not be rehearsed here, although the inquiring student may well consider them, inasmuch as each but raises to consciousness a further problem, which might itself be investigated by some such procedure as that here followed. In this field as in many others the mere raising of problems to consciousness and their preliminary attack by methods however inadequate may constitute significant contribution.

CHAPTER XV

PSYCHOLOGY FOR THE SOCIAL WORKER

The Causes of Misery.—In the case of social work there is afforded the best possible example of a field in which the contribution of psychology is essentially in the form of content or knowledge, rather than by way of attitude or technique. The probation officer, social visitor, charities investigator, eugenic field worker, child-placing agent or settlement organizer who attempts to pursue such work without an adequate knowledge of the characteristics, types and variations of human nature, a clear understanding of the original tendencies of mankind, some degree of acquaintance with the psycho-biological facts of heredity, and especially a familiarity with the various signs and consequences of mental deviation and abnormality, must work blindly.

However important, among the causes of misery, the economic institutions, industrial forms of organization, and environmental inequalities may be, most conspicuous of all are those traits of human nature which classify their possessor as incompetent, irresponsible, stupid, neurotic, feeble-minded or insane. Studies of vagrants and of hoboes in large

cities have revealed the fact that by actual mental examination a very large proportion are of a grade of mental capacity less than that of a ten-year-old child, although they are physically and chronologically adult. In the light of such facts, while one may still be concerned for the regeneration of the hobo, his "wanderlust" assumes a very different aspect from that which the romances of gypsy life commonly emphasize.

During a recent winter the vast number of the "unemployed" applying for food, clothing and shelter led to a careful investigation of a large number of such applicants, chosen at random from the large number. Of those so examined one out of every seven adult men was found to have an intelligence coefficient of less than 70 per cent, that is, to be definitely feeble-minded or worse. In the population at large, however, only about one in every 200 has such low mentality. The frequency of mental defectiveness among these unemployed was thus about thirty times as great as among the general population. Moreover, for such a group to contain so large a proportion of such low grade cases implies that the great majority of the group stood just above the border line of mental defectiveness. And these considerations do not take into account a very large proportion of the men, who although not of originally feeble mind, were chronically alcoholic or possessed of other vicious habits which were mentally and physically incapacitating in their effects.

No matter how one seeks to explain or interpret these striking results, it is still true that mental incompetence was in great measure if not entirely responsible for the fact that these "unemployables" became a burden on public and private philanthropy. Attempts to remedy the effects without understanding the cause merely involve the worker in an endless task. The social worker engaged in the actual handling of these cases of misery, or in the amelioration of such social or economic conditions as may have aided in the revelation of incompetence should above all things be able, in dealing with the cases as individuals, to recognize the signs and symptoms of mental abnormality and to be alert to their significance if present. Reformers interested in modifying legislation toward economic readjustment in the interests of the miserable can no more safely ignore the mentality of their clientele than can the bridge builder ignore the base on which his piers are built.

The large body of psychological knowledge relating to the nature, varieties and treatment of mental deviation can by no means be even outlined in such a chapter as this. Nor can space be given to any presentation of such socially important matters as the physical, social or hereditary influences in part responsible for the incidence of mental disorder. In the study of psychopathology and especially in the study of mental hygiene and the rapidly growing body of experience relating to the importance of psychogenic and functional influences and

mechanisms on the integrity of feeling, thought and conduct, the social worker finds a major occupation.

The psychology of habit formation and adaptation is no less important. When not dependent on a background of physical and mental incapacity, misery often results from the formation of vicious habits,—such as those of idleness, gambling, the use of drugs, gang life, sexual irregularity, etc. One familiar with the psychology of habit and learning readily realizes the hopelessness of attempting to change destructive habits through mere exhortation, instruction or the infliction of penalty. The breaking up of an established habit can be best accomplished by the formation of a counter tendency of greater strength. But the formation of new habits cannot be verbally impressed. The new habit, if it is to be well grounded, must issue on the background of spontaneous purpose, desire and determination. No amount of petition, reproach or ridicule can take the place of the "will to learn." In training animals it is found that repeatedly putting the creature's limbs through the series of movements he is expected to perform does not lead to his acquiring such a motor habit. Much more effective are his own spontaneous and random efforts to achieve some desired end or reward, if perchance this reward can be secured only through the accidental stumbling upon the appropriate course of conduct. The reform of the social derelict must in much the same way come from within rather than from without, and

comprehension of the laws of habit and adaptation may save the social worker not only much time and energy but also much chagrin and self-reproach.

Delinquency and Deficiency.—Equally important are the existence, diagnosis and consequences of mental deficiency and abnormality for the probation officer, the truant officer, and those in charge of orphanages, refuges, homes for the delinquent, and organizations for the placing of homeless children. The following table [1] shows the proportion of the inmates of various reformatories and refuges who are by actual examination found to be mentally deficient.

Institution	Per cent Defective
St. Cloud, Minnesota, Reformatory	54 per cent
Rahway, New Jersey, Reformatory	46 " "
Bedford, New York, Reformatory	80 " "
Lancaster, Mass., Girls' Reformatory	60 " "
Lancaster, Mass., Paroled Girls	82 " "
Westboro, Mass., Lyman School for Boys	28 " "
Pentonville, Ill., Juveniles	40 " "
Massachusetts Reformatory, Concord	52 " "
Newark, New Jersey, Juvenile Court	66 " "
Elmira, New York, Reformatory	70 " "
Geneva, Ill.	89 " "
Ohio Boys' School	70 " "
Ohio Girls' School	70 " "
Virginia, three reformatories	79 " "
New Jersey State Home for Girls	75 " "
Glenn Mills Schools, Pennsylvania, Girls	72 " "

[1] Above summary taken from Goddard, "Feeble-Mindedness, Its Causes and Consequences."

In the long run it would seem safe to say that at least half of the inmates of such reform institutions are mentally incompetent. Precisely how close a relation this indicates between juvenile delinquency and mental deficiency it is not easy to say, since in these cases we are dealing only with those delinquents whose low intelligence did not enable them to escape or to cover up their delinquency. It is at least clear that those delinquents with whom the social worker comes in contact should always be approached in the light of their known mental status.

In a recent investigation of truancy, one hundred and fifty cases, including boys and girls, were mentally examined by approved psychological methods. "Of all the truants, 43% were actually feeble-minded and 8% were border line cases." Concerning these the investigator, Miss Elizabeth Irwin, writes:

> Legally these cases do not belong to the attendance officer and it is simply because their true difficulty is undetected that 43% of the 150 cases were on the truant lists at all. If 43% of the actual number are mentally defective, surely a much larger proportion than 43% of the attendance officer's time is spent on these cases, for they are the hardest and most hopeless and the least improvable of all the cases with which he has to deal. Every effort made by the attendance officer on these cases is an effort to push a square peg into a round hole.

In institutions such as reformatories and prisons in which various forms of self-governing and honor

systems of control and management have been instituted it is found that a disregard of the presence of the mental defective means inevitably the breakdown of the system and consequent major or minor local disaster as well as general penological impediment.

Especially in the case of women and girls is mental deficiency likely to involve some catastrophe which labels the unfortunate person as a delinquent. Prostitution, abandonment of children, illegitimate parenthood, cruelty, vagrancy, are all of them dependent to considerable degree on the feeble-mindedness of the women and girls involved, and the consequent ease with which they are preyed on by unscrupulous or equally feeble-minded men and boys. The feeble-minded girl or woman is a particularly grave social problem for various reasons. The noncompetitive character of the work into which women traditionally drift means a small likelihood of the detection of feeble-mindedness except under conditions of special attention or catastrophe. Further, we are now coming to realize that feeble-minded parents mean feeble-minded offspring.

It would be unpsychological indeed to assert that all delinquency results from mental deficiency, instability or disorder. The important point is that these factors are so frequently the responsible ones that no social worker, however earnest and zealous, can be of maximum service without more or less familiarity with the facts of mental abnormality and

the methods or agencies in the use of which its diagnosis may be made.

By way of illustration may be given the results of a study of 1,000 consecutive cases brought to the Clearing House for Mental Defectives of New York City. Of these 1,000 cases, 568 were males and 432 females. The following table shows the relation between mental age and actual age at the time of examination, for each sex separately.

Showing the Relation Between Mental Age and Actual Age at the Time of Examination

Mental Age, Yrs. (Binet)	Actual Age When Brought to the Clearing House					
	Males			Females		
	Average	A.D.	Cases	Average	A.D.	Cases
0-4	7.1	3.2	92	8.1	3.8	65
4-5	9.2	2.4	29	11.4	4.3	16
5-6	12.6	4.2	25	13.2	4.3	32
6-7	11.4	2.9	42	15.8	6.0	40
7-8	13.5	2.9	76	15.0	4.6	45
8-9	12.9	2.5	82	17.2	5.1	56
9-10	14.0	2.7	70	17.3	4.3	53
10-11	15.2	2.7	57	18.5	5.4	46
11-12	14.2	1.0	20	17.7	2.5	27
12+	13.0	0.0	4	16.8	2.9	6

The facts are as follows:

1.—More males than females are brought to the Clearing House in a ratio of about 1.3 to 1.0.

2.—At the age of 1-2 years the frequency for males and females is equal. From the age of 2 to the age of 16 there is a very marked preponderance of males. At the age of 16 the curves cross and from that point on there is a very marked preponderance of females.

3.—Females survive in the social *milieu* till beyond the age of 16 years twice as frequently as do males; females survive in the social *milieu* till beyond the age of 30 years three times as frequently as males.

4.—The Binet measuring scale shows that for all mental ages the average actual age at examination is older for girls than for boys—this difference becoming very marked after the mental age of 6 years.

The figures show, for instance, that a female with a mental age of 6 years survives in society about as well as a male with a mental age of 10 or 11 years.

5.—The average deviations from the above averages are greater in all cases for girls than for boys, indicating that any male is much more certain to be brought to the Clearing House at a given average age than is a female of the same degree of defectiveness.

6.—Of the 159 women over 16 years of age, the majority had found a more or less secure economic basis for survival either in housework or in prostitution.

Commenting on the significance of these facts, the investigator writes as follows: [2]

These facts are interesting and significant for all who are immediately or remotely concerned with social problems. To interpret them we have but to reflect on our social organization. Women are not a competitive class. Their work is housework, performed in isolation and not in competition with others for a wage. Moreover, in our social organization, sex as such may easily become a commercial asset to women, and opens to them ways wherein they can survive without much regard to mental deficiency. Men, on the other hand, form a highly competitive class, working together in competition, for a wage. The boy who cannot compete mentally becomes at an early age an object of concern to relatives, is brought to the clinic and is directed toward an institution. The girl who cannot compete mentally is not so often recognized as definitely defective, since it is not unnatural for her to drop into the isolation of the home where she can "take care of" small children, peel potatoes, scrub, etc. If physically passable, as is often the case, she may marry, thus fastening herself to economic support; or she may become a prostitute, to which economic pursuit feeble mentality is no barrier. Thus they survive outside of institutions. Our data here reveal how accidental are the causes which finally bring them after thirty years to the Clearing House. The writer has frequently questioned those who accompany them when they come. Answers like these are typical: "Her husband has just died"; "She got rheumatism and can scrub no more"; "She was a prostitute, but physical illness has driven her from the street." No one can doubt that there are scores

[2] "The Frequency of Amentia as Related to Sex," Dr. Leta S. Hollingworth, *Medical Record,* Oct. 25, 1913.

of feeble-minded women at large to whom these accidents have not happened.

The Nature of Abnormality.—The history of the agencies of social amelioration from the middle ages to a very recent epoch is marred by the persistent failure to understand the nature of mental abnormality. Bodily disorders were readily handed over to the medicine man or the doctor. But mental abnormality until very recent years was looked on with superstitious ignorance as a token of some sort or degree of social crime, religious punishment or astrological disaster. The mentally abnormal, far from being treated as sick bodies or sick souls, were imprisoned in dungeons, beaten, scourged, tortured, burned or turned loose to die in desert or wilderness. Even in our own generation the failure to comprehend the nature of mental abnormality has led to methods of social treatment and restraint in which the imbecile, the epileptic, the insane, the pauper and the criminal were huddled together in jail, without occupation, exercise, segregation or proper nursing. The failure to realize the hereditary character of at least some forms of mental disorder has led to the multiplication of family strains which no amount of social zeal can easily eliminate.

One of the most useful concepts that the social worker in any branch of service can acquire is that of the curve of distribution of mental traits. By this is meant the fact that human beings do not fall

into sharply separated types or species such as the normal, the feeble-minded, the insane, etc. Instead, in any single trait that might be measured the human family would be found to constitute but a single species,—to fall into the limits of a normal curve of distribution. Such a curve of frequency means (a) that all degrees of any trait or characteristic will be found to occur; (b) that certain degrees of it, the median, modal or average degrees occur most frequently, so that (c) those individuals possessing this median degree of the trait constitute the normal or typical, while (d) as one goes above or below this region of normality the individuals become fewer and fewer.

The stupid, the feeble-minded, the imbecile, the idiotic, are thus in no sense distinct or peculiar types, but represent the lower degrees of capacity, just as the competent, the talented, the distinguished and the individuals of genius represent the extreme degrees in the more desirable direction. The distinctions are practical, social, statistical, rather than qualitative and psychological. Similarly in the case of the insane no unique nor novel characteristics are present. The symptoms that lead to classification are but the exaggeration or the reduction, to greater or less degree, of characteristics, reactions, mechanisms and tendencies possessed by all mankind. Normal and abnormal are then mainly differences in degree. Insanity is more a type of character than it is a definite disease entity, and in the various clin-

ical pictures one sees "normal" human nature as through a telescope. Between the "normal" and the "abnormal" come the "border line cases," less frequent than the normal but more frequent than the obviously abnormal, and of equal or even greater social significance.

The Abstraction Fallacy.—The foregoing facts concerning the nature of mental variation and the distribution of human traits should also be of special significance to the social worker who is more interested in the contemplation of the social program than in actual participation in its events. The social philosopher has until very recent times been misled by the very common and hence natural fallacy of conceptualizing the descriptive facts of history and then treating them as if they were active agents rather than convenient abstractions. The result has been that in social discussions and program-making the concrete and varying individuals who make up the population have frequently been neglected in favor of such inactive abstractions or words as "labor," "capital," "the state," "the family," "custom," "public opinion," etc. It has been especially difficult for the social philosopher to realize that "people in general" are not "general people," and that similarity of conduct does not imply identity or singleness of motive.

Thus when a wave of coughing passes through a multitude, the social philosopher deftly dismisses the phenomenon as a case of "imitation," the fact being

that each single individual coughs for his own particular individual reason, just as he coughs in his own particular individual larynx. The descriptive fact of "similarity," while it may serve the purpose of historical record and generalization, can by no means be conceptualized into such an active and explanatory agent as "imitation." Similarly social resemblances are not caused by "custom," but in themselves constitute what is meant descriptively or historically by that term. In so far as this is true, the "individualization of sociology" and of the point of view of the social worker (in time perhaps of the social philosopher as well) may happily result as a useful application of the psychology of individual differences.

CHAPTER XVI

PSYCHOLOGY AND MEDICINE

General Relations.—In considering the relations of psychology and medicine it is obvious that one does not have in mind that type of psychology which limits itself to the introspective analysis of the elements of consciousness and the forms and patterns of their combination. The psychology which admits of practical application in any field is that larger science which occupies itself with the behavior of organisms in so far as that behavior is at one time or another paralleled by consciousness or is directly conditioned by the modifiable activity of the nervous system. Two forms of behavior are to be distinguished in the subject matter of this psychology,—the one constituted by the behavior of mental processes and the mechanisms of consciousness; the other by the motor behavior of the body and the mechanisms of activity. Under the first we study such functions as sensation, imagery, association, feeling, emotion, motivation, meaning, impulse; under the second such topics as habit, instinct, attention, fatigue, learning, work, practice, reaction, etc. Of

course most of these topics are, as a matter of fact, interesting from both points of view.

It is necessary to consider in this connection not only such work as professional psychologists have accomplished, but all work that can properly be called psychology in the light of the definition we have just given. Much psychological work has been done by medical investigators, but their work, in so far as it is valid, is none the less psychological because of the mere fact of their medical training. Lester Ward was an eminent botanist, but his many valuable contributions to sociology are not for that reason to be credited to the science of botany.

A science is, on the one hand, a more or less unique method or set of methods of controlling or examining phenomena. On the other hand, it is a more or less systematic array of facts, data and laws, acquired or established by the use of some such methodology. The incidental applications of the science may be based on the methodology, or on the resultant knowledge or on both. In a discussion of the extrinsic usefulness of any given science it is well to bear this in mind, and any attempt to extend the application of such science should be supported by discernment of the direction in which the possibilities are conceived to lie. A mere ardor to be of service is bound to prove either inadequate or mystifying.

From the point of view of method and from the point of view of content, then, what have been the

contributions of psychology to medicine, and what further serviceableness may we reasonably expect? It may be said at once that in so far as medicine has profited from its utilization of psychology, this profit has been mainly by way of methodology and technique. In so far as there has been any interchange of content, psychology has been far more blessed in its receiving than in its giving. Medical clinics and medical practices have been drawn on freely for data, problems, suggestions and illustrations, and psychology still shows, in many quarters, pronounced anatomical, physiological and clinical leanings.

The affiliation of psychology with medicine is of necessity a most intimate one, and this has long been recognized. Lotze's "Medicinische Psychologie" on the one hand and Tuke's "Dictionary of Psychological Medicine" on the other bear testimony to this affiliation. Or we may pair off in much the same way the various textbooks of physiological psychology, written by psychologists, and the books on abnormal psychology written for the most part by medical men. The Vienna and Zurich schools of psychiatry make much use of psycho-analysis, which in its various forms is but an elaboration of classical experiments of the psychological laboratory. On the other hand men and women whose chief interests are psychological are seeking and being appointed to research positions in connection with many of our leading hospitals. All of these facts indicate that

psychology and medicine are, in part at least, joint tenants of some common ground of content or of method.

The contributions or relations of psychology to medicine may be presented under six chief headings. We shall briefly point out these six directions, illustrate them, and indicate whether the contribution is chiefly of content or of method.

Psychological Researches on Patients.—Three subdivisions may be pointed out here:

(a) The mental and motor behavior of patients, as studied by psychological methods, may reflect their organic condition. Knowledge of this condition may be useful to the physician, particularly if a nervous disorder is involved. An illustration of this type of work is to be found in the recent studies by Dr. F. L. Wells, on the behavior of manic-depressive patients, in such performances as speed of tapping, speed and quality of association, sensory discrimination, distraction, etc. Interesting correlations are found between performance in the tests and organic condition at various times in the history of the case.

(b) Knowledge of the normal types and range of variation in mental processes may prove of great assistance in diagnosis of supposedly abnormal cases, and may be of general use in clinical procedure. The work of Kent and Rosanoff on the association reactions of normal and abnormal individuals may be cited as an illustration in this field. A list of 100 test words was arranged, and the free

associations to these 100 stimulus words, in the case of 1,000 normal people, were experimentally determined. When the character of these associates was studied, it was found possible to make out normal tendencies in the case of each stimulus word, and also a normal range of variability within this tendency. When these associations were classified according to quality, under such headings as rime, neologism, perseveration, individual reactions, etc., the association types of normal people could be made out.

The same test words were given to 247 patients, suffering from the various forms of insanity, and these associations similarly studied. Comparison of these results with the results secured from normal subjects enabled the investigators to draw such conclusions as the following:

> With the aid of the frequency tables and the appendix, normal reactions, with a very few exceptions, can be sharply distinguished from pathological ones. The separation . . . simplifies the task of analysis and makes possible the application of a classification based on objective criteria. . . . In *dementia præcox,* some paranoiac conditions, manic-depressive insanity, general paresis, and epileptic dementia the test reveals some characteristic, though not pathognomonic associational tendencies.

Further studies of this sort are in progress; they are at once thoroughly psychological and medically useful.

(c) Psychological examination may often be valuable in measuring or demonstrating the efficacy of various treatments for abnormal physical condition. By way of example the psychological examination of hookworm patients recently made by Strong may be given. By a series of tests this psychologist measured the mental alertness and capacity of children who were about to be placed under treatment. At the same time he examined in the same way a control group of healthy children living under the same general condition, and also a group of hookworm infected children who were not submitted to treatment. After the treatment the various groups were reëxamined by the psychological tests and determination made of such changes in mental condition as may be produced in the normal and untreated groups by mere repetition and growth, and in the treated group by these factors plus medical treatment for the disease.

The results of this investigation enabled the investigators to draw the following conclusions:

The figures show, then, that hookworm disease unmistakably affects mental development. Treatment alleviates this condition to some extent but it does not, immediately at least, permit the child to gain as he would if he had not had the disease. And the figures apparently further show that prolonged infection may produce prolonged effects upon mentality—effects from which the individual may never entirely recover.

This investigation by psychologists bears out the claims

advanced but not measured by physicians and zoölogists that the effect of hookworm infection may result in serious delay in development of mental activities of children and of communities, and may therefore have a seriously inhibitive effect upon the school problems and even upon the economic development of hookworm communities.

It emphasizes more than does any previous study the advisability of prompt medical treatment even of light cases, for the benefit of the children themselves and collectively for the better development of the community.[1]

In this field then such contribution as psychology may be making to medicine is both by way of technique and by way of information. But the information is itself used by the medical man not for its psychological value alone, but largely to reënforce or supplement his own methods and technique.

Researches on the Immediate Effects of Drugs.—Here medicine must be said to owe a great deal to psychology, and the chief contribution has been by way of perfected methods. By way of illustration one need only compare the unreliable, roughly made experiments of Kraepelin and his earlier students with certain rigorously controlled investigations which have been carried on in psychological laboratories by Rivers, Dodge, Wells, the writers, and others. The trouble with the earlier workers was that they knew too little about psychological laws, psychological sources of error, and the technical cautions which must be observed in conducting cru-

[1] Strong, "The Effects of Hookworm Disease."

cial experiments on mental and motor reactions. Later workers have been more familiar with these factors, and they have drawn their knowledge not at all from the field of pharmacology but directly from the psychological laboratory. Four points may be noted as especially important in the improvement of scientific technique in drug experimentation.

The Importance of Controlled Conditions.—This is of course a most obvious factor. However, in many sciences the general conditions are so stable and uniform that many of them may be practically disregarded for the purposes of simple experiment. Thus the temperature of the room, the day of the week, the noonday menu, the sex of the operator, and a hundred other conditions are irrelevant to the outcome of an experiment in physics, chemistry or botany. But in a psychological experiment these factors may play an important rôle. Nevertheless one need go back only so far as the time of Kraepelin's drug experiments to find men investigating the influence of tea and coffee in the evenings of days on which the subjects of the experiments had taken both strychnin and alcohol, experimentally, at an earlier hour. We now know, and partly as a result of work done in psychological laboratories, that the primary influence of so mild a drug as caffeine may persist for twenty-four hours or more.

Importance of Control Groups.—A second important point in technique, the recognition of which is at least in part due to the influence of psychological

methods, is the necessity of a *control squad.* The account of the control group of normal children in the case of the hookworm experiments may be recalled in this connection. In the case of recent experiments on the influence of caffeine, a control squad ran through the entire experiment, covering a period of six weeks, taking daily doses along with the other subjects. But these doses, although this was known only to the director of the experiment, consisted of nothing but sugar of milk.

This is of course only another point under the general one of controlling the conditions, and it enables the investigator to compare his drug records with records of undrugged subjects, acting under the same conditions of practice, excitement, suggestion, interest, expectation, ennui, fatigue and diurnal variation. This again is a most obvious point, yet only a few years ago a medical expert of repute was heard to assert that a certain drug produced congestion of the cerebral blood vessels, because an animal which had been fed this drug was found to be in this condition after having been killed by a blow on the head. A control animal, which should be struck on the head but not fed the drug, seemed not to have been even considered, although the experiment was deliberately performed and in an important connection.

The Importance of Control Doses.—This may also be pointed out. The medical experiments on drugs, until within quite recent years, proceeded by ad-

ministering, at a known time, a known drug, to a subject who had his own prejudices and opinions, who was aware of the whole situation, was open to all manner of suggestion, and who was at any rate more or less interested in the outcome of the test, and perhaps excited at the thought of taking the drug in question. Yet any change in performance under these gross conditions was likely to be attributed to the direct action of the drug. It was not until Feré, a psychologist, demonstrated the stimulating effect of the mere act of swallowing, or indeed of simply holding in the mouth, a drink of whiskey, thus getting odor, taste, and any conceivable amount of suggestion, excitement, etc.; and until Rivers, another psychologist, wrote his illuminating paragraphs on the technique of drug experimentation, that medical experimenters came to realize the importance of the two factors of sensory stimulation and suggestion.

The Standardization of Tests.—This constitutes a fourth point in such technique. Many of the tasks set the subjects of drug experiments before the psychologists addressed themselves to the standardization of series of tests for definite functions or processes, measured processes which varied not only from individual to individual but even from moment to moment or from day to day with a single individual. The much used cancellation test is an instance of such an ambiguous task. It must be said that a great deal remains to be done in the way of

standardization of tests, but the point to be made here is that it is work which must be done by the psychologist, and which when done will represent a valuable contribution to the equipment of medical workers.

The Use of Psychological Agents.—This third general topic is one on which the psychologist might be expected to dilate at great length. It is the one about which most has been written and which is quite commonly supposed to constitute the most important direction in which psychology may contribute to medicine. Suggestion, hypnotism, reëducation, synthesis, clarification of complexes, catharsis, association and dissociation are the words that come to mind in this connection. That some of them are psychological words there can be no doubt. That they represent genuine mental processes, states or functions, and that psychologists are interested in discovering and formulating their laws, must be granted. But it is equally certain that no little obfuscation has been caused by pseudo-scientific writers who have attempted to arouse dramatic interest in certain phenomena of fatigue, automatism, drowsiness and hysteria, and have drawn into their service in this attempt the occult suggestions which formerly emanated from the words suggestion and hypnotism. As for the terms reëducation and synthesis, they are not, properly speaking, psychological terms at all, but represent large and practical processes, with little attempt at psychological analysis,

description or formulation. And as for the last two processes, association and dissociation, psychology has done little more than incorporate in its own literature fragmentary clinical pictures and various medical speculations. The processes intended by the words suggestion, reëducation, synthesis, etc., in the manuals on psychotherapy really move on the same plane, psychologically, as do such expressions as "lend a helping hand," "set a good example," "give direction and advice," "provide an incentive," "give encouragement," "take a little exercise," "arrange for new surroundings," "jog the memory," etc. All these phrases, it is true, emphasize the mental functions of a psychophysical organism rather than its physiological processes. This emphasis is perhaps responsible for the first two syllables of the word "psychotherapy." And it follows, of course, that acquaintance with the laws of mental and motor behavior and with the elements, attributes, genesis and patterns of mental processes is favorable to satisfactory work on this plane, as it is also in teaching children, hunting wild beasts and selling goods. The point is that the use of these psychological agents does not require any very profound knowledge of the refinements of modern psychology, but rather a sympathetic acquaintance with and toleration for human nature. The contribution of psychology at this point is not specific in character but is rather a general, cultural contribution. It seems well to add that the contribution here will

become more and more specific when psychology begins to occupy itself still more with the way in which mind works, and less with what is in the mind at the moment of its operation.

One of the recent psychological tendencies in medical practice and medical speculation may deserve special attention at this point,—that form of psychotherapy known as psycho-analysis. The psychoanalysts proceed on the assumption that emotional experiences and complexes which persist in an unclear or subconscious way,—fears, wishes, etc.—are nevertheless active determinants of action, thought and feeling. They act chiefly as disturbers; they disturb our sleep by dreams; they disturb our daily life by producing phobias, obsessions, dissociations, amnesias, slips of hand and tongue, etc. Furthermore, it is claimed that by some form of the simple association experiment, skillfully conducted by an experienced analyst, these complexes may be discovered, brought into clear consciousness, dissipated, and the sufferer thereby relieved. The work of Freud, Jung, Adler, Brill, Jones and others, may be cited here.

It must be said that psychologists are by no means unanimous in their reactions toward the claims, evidence, and interpretations of the psycho-analysts. But the lack of unanimity of individual psychologists is one of the things that makes the science interesting. We must say at least that in so far as psycho-analysis throws genuine light on the causes,

conditions and prognosis of functional disorders, and in so far as its technique affords relief which ordinary therapeutic measures fail to give, it represents a real contribution to medical science. How far this may be remains for the future to determine. It should, however, be pointed out that the mere therapeutic success of a technique in no way constitutes a proof of such speculation as the practitioner may incidentally indulge in, nor does it by itself validate the fundamental assumptions and hypotheses underlying the technique.

The Determination of the Organic Conditions of Efficiency.—This constitutes a fourth general field in which psychology may make specific contribution to medicine. The contribution here is peculiar in that it may often appear to be but a contradiction of the deliveries of medical science. We may call attention to but two subdivisions of this general topic,—Fatigue and periodicity.

Fatigue.—The investigation of muscular fatigue is so near the border line of physiology and psychology that little need be said of it here. Perhaps the one important point is the fact that psychological studies tend constantly to emphasize the importance of purely mental factors in the production of supposedly muscular inefficiency;—such factors as ennui, loss of interest, the inhibitory action of sensations of strain, work habits, and the customary or traditional level of fatigue sensation. The distinction between actual exhaustion and mere ces-

sation of work because of psychic inhibition, a distinction constantly exemplified during psychological investigations of fatigue and work, would seem to be important in medical diagnosis and therapeutics.

With respect to mental fatigue, the net outcome of psychological studies up to date is that the more muscular fatigue is eliminated from a given task the more unfatiguable does the process become. This is often expressed by saying that purely mental fatigue has never been satisfactorily demonstrated. Of course it is also true that no purely mental process has ever been isolated. There seems to be little doubt that by the coöperation of medical science with psychological investigation, information may ultimately be secured concerning the nature and causes of fatigue which will be of service to both fields of work.

Periodicity.—But nowhere is psychology more at variance with medical science than on the question of the relation between organic periodicity and psychomotor efficiency. By way of illustration of this variance we may refer to the declarations of the periodic inefficiency of women,—declarations in which medical and semi-medical books abound. It is not necessary to entertain the reader with the many available quotations from general writers, but two or three statements may be presented direct from the pens of eminent medical men, by way of showing their contrast with the results of carefully

controlled psychological experiment and measurement.

Max Runge, a gynecologist of Göttingen, wrote in 1900:

> An experienced observer will be able to note many interesting phases in the mental changes of women at menstruation. Even though scientific experiments are as yet lacking, it may nevertheless be stated that a very great number of healthy women are mentally different during this period.—All demands on her strength must be remitted.—For several days she is enfeebled.

Icard, writing in 1890, concludes:

> The psychical and physical state of woman during the menstrual period seems to me to constitute one of the chief reasons why she should not administer public affairs. Indeed one cannot depend on a health so fragile and so often disturbed; the errors of judgment and the false evaluations so often made at that time prove that women are unable to undertake comfortably and successfully that which should be the exclusive lot of the strong sex. The menstrual function may, especially in the case of the predisposed, induce sympathetically a mental state varying from a slight psychosis—to absolute irresponsibility. Such is the proposition which I lay down and which I shall endeavor to demonstrate.—I shall cite in support of my thesis the opinions of the most famous authors.[2] From time to time I shall let the ancients speak.—I have consulted distinguished alienists, father confessors, the directors of convents, superintendents of boarding schools, and homes of

[2] Meaning the romantic novelists.

refuge, midwives, women of the world—I can do no better than to resay badly in prose what Alfred de Musset has said so well in verse. . . .

And authors writing as late as 1909 refer to Icard's work as the most authentic and reliable discussion of the subject!

Ellis writes on the basis of considerable familiarity with medical literature, as follows:

> It is but the outward manifestation of a monthly physiological cycle which influences throughout the month the whole of a woman's physical and psychic organism. Whatever organic activities we investigate with any precision, we find traces of this rhythm. While a man may be said at all events relatively to live on a plane, a woman always lives on the upward or downward slope of a curve. This is a fact of the very first importance in the study of the physiological or psychological phenomena in women. Unless we always bear it in mind we cannot attain to any true knowledge of the physical, mental or moral life of women.

Mosher's experiments on blood pressure are often cited in evidence of this periodicity. But the writers who quote Mosher seem not to have observed that the investigator also studied blood pressure in men and states in the original report, "The daily records of the blood pressure . . . on men and women under similar condition of life and occupation give curves apparently indistinguishable in character." Here again we see the value and indispensability of the control squad.

In striking contrast with these assertions of periodic psychical changes dependent on organic rhythms are the results of a recently reported elaborate experimental study [3] of the facts. The investigator tested, under controlled conditions, twenty-three women for a considerable period of time, measuring constantly the efficiency with which various mental and motor tasks were performed. The tests included measures of steadiness, speed of movement, fatigue, rate and accuracy of perception, swiftness and correctness of association, and ease of learning. Men subjects were used as a control group. The results are described as follows:

1.—Careful and exact measurement does not reveal a periodic mental or motor inefficiency in normal women.

2.—The variability of performance is not affected by physiological periodicity.

3.—No regularly recurring period of maximum efficiency within each month is discernible. The "cycle" referred to by Ellis and others is not discovered by methods of precision.

4.—No agreement is established between curves previously platted for pulse, blood pressure, temperature, caloric radiation, etc., and the curves of work for the mental and motor traits here tested.

We need not attempt in this connection to settle the dispute over the question of periodicity in mental and motor capacity as dependent on organic

[3] L. S. Hollingworth, "Functional Periodicity."

rhythms. Nor shall we consider the reliability of other alleged rhythms, diurnal variations in efficiency, periodicity in men, etc. The important point is that the findings of modern experimental psychology, based on examination of normal people, are on many of these points much at variance with the generalized clinical findings and anecdotes of medical men.

The Psychological Clinic.—An important development of applied psychology in recent years has been the psychological clinic. In such clinics individuals are examined by various methods and scales of mental measurement. By these means it is possible, to a degree of accuracy and completeness never before attained, to determine the mental condition and status. Such determination in these days of individualized pedagogy, individualized punishment and industrial emphasis on the individual worker is a highly desirable procedure for educational, criminological and vocational diagnosis.

The contact of psychology with medicine at this point arises from the fact that the determination of mental status has in times past, for rather obscure and complex reasons, been assigned to the medical man, rather than to the educator, lawyer, clergyman or psychologist. Commitment for lunacy, invalidation of wills, evaluation of testimony, appointment of guardians and determination of legal or criminal responsibility are still in many parts of the country dependent on the verdict of physicians whose chief

practice may be in surgery or obstetrics. This has been the case although in only two or three medical schools is the prospective physician required to give any appreciable amount of his time to the study of mental normality or disorder. Even the work of institutional administration and superintendence has traditionally been that of the physician, when mental deviates and their care were in consideration.

In recent years two movements have developed, both calculated to remedy this obviously unsatisfactory tradition. On the one hand there has arisen a group of specialists in nervous and mental diseases, the psychiatrists. These are usually men or women with the ordinary medical training, who after their medical course have taken occasion, largely through interneship or special practice and observation, to familiarize themselves in more or less adequate ways with normal and abnormal psychology. On the other hand a group of psychopathologists or clinical psychologists has arisen, taking their point of departure mainly from the psychological laboratory, and familiarizing themselves more or less adequately with such branches of science as neurology, physiology, biological chemistry, etc.

In the psychological clinic of today as well as in the progressive hospital for the mentally disordered and defective, both psychiatrists and clinical psychologists will commonly be found applying to the concrete problems of education, charity, justice, industry and social administration, such of the

content and technique of medical and psychological science as may be found serviceable.

Psychology and the Medical School.—Our general conclusion is then that the chief contribution which psychology has made and may be expected to continue to make to medical science is methodological in character. There seem to be two principal reasons for this:

In the first place, the experience and training of the medical student are largely clinical. This means that his observation is for the most part of pathological conditions. He may easily fail to acquire sufficient information concerning normal types, and the direction, conditions and range of normal variability. Such knowledge, which might well be partially furnished by adequate psychological training, might at least warn him of the fallacies of generalizing clinical findings.

In the second place, the medical course as it is now offered seems to provide little training in exact and purposive experimentation. An excessive proportion of the student's time seems to be occupied with the memorizing of anatomical minutiae, the most of which are straightway forgotten, the disciplinary value of which is at least questionable, and the content of which is always accessible in the manuals. It seems for these reasons that one of the most fruitful contributions which psychology may yet make to medicine may be a rigorous, specially adapted, full year course in experimental psychology,

which should be incorporated at an early point in the curriculum of the medical schools. In such a course much stress should be laid on methods and technique of arriving at experimental certainty, avoiding logical fallacies and inductive errors, and of adequately controlling the grounds of inference under circumstances in which very slight factors may play important rôles.

CHAPTER XVII

PSYCHOLOGY AND EDUCATION

The field of education represents the first practical activity in which the applications of psychology were made in any systematic way. So numerous and so varied have these applications become that a working knowledge of psychology is now quite generally required of all teachers. In training schools for teachers the courses in general, experimental, genetic, abnormal and differential psychology constitute an important part of the curriculum. Books on the principles of teaching quite commonly begin with some such statement as, "The art of teaching is based primarily on the science of psychology." Not only have certain facts and principles of psychology become systematized into a body of "educational psychology," but the individual and group methods of the laboratory have been adapted to special educational problems under the name of "experimental pedagogy" or "experimental education."

Between these two fields, psychology and education, the coöperation has been so long established

and so cordial that the content of general psychology has been much enriched through investigations, the primary problems of which were educational. Since these things are true, a chapter on the relations of psychology to education can only indicate the main directions of application and give suggestive illustrations of each. This may perhaps best be done by adhering to our familiar classification of applications under attitude, content and technique.

The Psychological Attitude in Education.—The attitude of analysis and its practical value is seen in every modern attempt to discuss the nature or purpose of education. At an early time we find such definitions to consist of large generalities, in which the concept of education is more or less treated as if it were some single, unitary process, and its function maintained to be "training the mind," "molding character," "giving culture." A real step, however inadequate we may now consider it, was taken when "the mind" was analyzed into distinguishable and nameable "faculties" and the effectiveness of teaching regarded from the point of view of these "faculties" and their separate treatment. Still more wholesome and influential was the further step in analysis in which these "faculties" (such as memory, instinct, imitation, perception, attention, will) were realized to be but convenient and artificial names given to various groups of specific habits and tendencies. With these steps went the breaking up of "learning" or "culture" into

more elementary and constituent aspects, the deliberate separation of school subjects from each other, and attempts to correlate them in the curriculum in such a manner that each set or group of tendencies or habits would be given adequate attention, exercise or inhibition.

In time this same analytic process led to the discovery that a "school subject," such as arithmetic, is by no means a unitary enterprise on the part of teacher or student, but in itself involves a considerable variety of more elementary processes, each of which must be considered in detail if the whole is to be adequately and economically mastered. Thus in arithmetic the ideas of amount, of units, of sequence and position, of counting, of grouping, and of manipulating, familiarity with the symbols, comprehension of the operations and meanings which the symbols denote, must all be recognized. Questions at once arise concerning the most "psychological" sequence and organization of these various functions and processes. In a similar way in the subject of drawing, the various tendencies and features of ornament, symbolic portrayal, pictorial representation, diagraming, and finally mechanical drawing are distinguished. Other "subjects" receive, at the hands of the educational psychologist, the same type of detailed analysis.

Not only is the school subject thus reduced to its constituent processes, but each operation in one of these processes is ultimately analyzed into a group

of still more specific acts and habits. Thus in such a simple operation as adding a column of numbers "investigation seems to give evidence that . . . eight or nine distinct functions are involved, each of which involves the use of several bonds. Besides these positive connections, a child in learning (to add) must inhibit other connections which are incorrect, and these must often outnumber the correct ones. And yet column addition has always (heretofore) been treated as a simple habit—with perhaps one element of complexity when carrying is involved. It is evident that if the habit concerned does involve eight or nine different functions, a child might go astray in any one. His difficulty in forming the habit might be in connection with one or several of the processes involved. Knowledge on the part of the teacher of these different steps of the habit, and appreciation by him of the possibilities of making errors, are the prerequisites of efficient teaching of habits."

The foregoing quotation, from Strayer and Norsworthy's "How to Teach," emphasizes precisely that value of analysis which we have already had occasion to consider in such diverse fields as bricklaying, dishwashing, housecleaning, writing an advertisement, selling life insurance, managing a factory, or making window screens. Improvement of the whole comes only through discernment of the parts, and such discernment involves that special

mental attitude of analysis which we have found to be so characteristic of psychology.

The attitude of analysis in education is important not only for an understanding of the true nature of school materials, but is equally valuable in the solution of other educational problems. Thus in modern administration and supervision there is to be seen a definite tendency away from the vague characterization of a teacher as "a good teacher," a "fair" one or a "poor" one, toward a thorough analysis of "teaching ability" into its elements. Moral influence, social activity, discipline, leadership, instruction, etc., come to receive independent recognition and evaluation. Indeed each of these is realized to be complex and the task of "teaching a class," from the point of view of instruction alone, is analyzed into such distinguishable though by no means unrelated steps or stages as "preparation," "presentation," "comparison and abstraction," "generalization," "application," and "drill or review." "Faulty instruction" can thus be understood or remedied only by the analysis of one of the qualifications of a teacher into still more elementary aspects.

In a similar way such a concept as that of the child's "will" has been clarified only by analyzing it into the constituent instinctive and emotional trends; these instinctive trends understood only by the enumeration of the specific bonds and reactions which the "instinct" includes; and the emotions

comprehended only by breaking them up into the elementary feelings and their combinations. These changes have clearly paralleled the analyses of physiological psychology, from the conception of the unitary brain as the "organ of mind," through the reduction of this unit into "areas" or "regions" of localization, the analysis of these "regions" into "arcs" and "pathways," and finally to the "neurone theory" and the consideration of particular conduction units, synapses, conditions of preparedness and readiness, inhibition, facilitation and integration.

The Content of Psychology in Education.—Perhaps the earliest contributions of psychology to education were in the form of facts or laws of mental life. Indeed long before psychology became recognized as an independent field of scientific inquiry writers on educational subjects were mainly occupied with discussions concerning the nature of the child's mind, the sources of his interest, the varieties of his powers and the modifiability of his capacities. The work of education came to be conceived as that of effecting changes in the behavior or feeling of the individual who was taught. The possibility of these changes was, of course, seen to depend not only on their social or parental desirability but most of all on the materials afforded,—the fund of traits and tendencies with which the individual is originally equipped, and the degree, permanence or modifiability of these traits.

The "original nature of man," his inborn tendencies to attend, react and retain, his predispositions, the range and limits of his capacities, the rate at which these mature, the conditions of their effective activity, their transitoriness, their mutual inhibitions and reënforcements, the teacher is compelled, either beforehand or through painful experience, to learn. For these original traits are given only in the form of certain large and vague tendencies and the task of education consists in so working with these vague original tendencies as to make the individual most effective in the circumstances and for the purposes for which he is to live. Some of these tendencies must be inhibited if the individual is to be socially adapted, as, for example, his tendencies to take what he sees, to strike when injured or affronted. Other tendencies must be selectively trained, stimulated and specialized, as his tendencies to vocal utterance, to motor activity, to construction. Still other tendencies must be directed, modified and transformed, as those to inquisitiveness, to collection of objects, to play and to hunt. In such processes it is important to know in some detail the ways in which original tendencies may be modified, the consequences of their enforced suppression, their futility unless directed. Punishment, disuse and substitution may all be employed in this process, but by no means all of them with equal success or on all occasions.

Still further reaction tendencies in the form of

feeling, conduct or knowledge, not provided by original nature, must be impressed on the individual in the form of habits. Talking, reading, writing, using a machine, the multiplication table, and a thousand habits, simple and complex, must all be individually acquired. It is the task of education to see that these habits are most adequately, economically and permanently acquired. Here then all the laws of learning, all the studies of memory, all the facts and principles of habit formation, interference, forgetting, association, etc., are of vital importance in the operations of the classroom, the laboratory and the textbook. Studies of animal learning yield principles which may be directly utilized in teaching the human being. The advantages of spontaneous effort over mechanical repetition, the relative effectiveness of reward and punishment, the influence of motive and incentive, the inadequacy of imitation, the importance of pleasure in success, the expectation of a systematic curve of learning, the meaning of plateaus, the value of determining tendencies, intentions and purposes, the value of problem or project, the character of play tendencies and their possibility of useful organization and direction, the specific nature of habits, the absence of any considerable transfer from one field to another, the significance of identical elements in materials, work habits or general attitudes, all these are but random selections from an endless list of principles which it is

the business of psychology to study and the business of the teacher to apply.

No less important than for the social worker, the judge, the manager and the physician are the facts of differential or individual psychology for the teacher. The knowledge of the ways in which individuals differ from each other, the degrees and directions of this variation, its causes and educational consequences is the foundation on which must be based all discipline, all differentiation of studies, all guidance and advice, all appointment and control. Every teacher of experience can narrate, from earlier years of work, case after case in which labor, worry and sacrifice were entailed by the failure to recognize, in the "problem," a mentally defective boy, an adolescent girl, a neurotic parent, a paranoid superintendent or a senile member of the board. Many a microcephalic child, with his irremediable mental limitations, has caused the teacher sleepless nights, and many a pupil has in turn been seriously impeded through life because of the principal's failure to understand the true nature of a speech defect, a choreic tic, or a proclivity for day-dreaming.

The individualization of pedagogy has set the key note for the individualization of most diverse fields of human activity, in spite of the institutional, administrative and financial obstacles which it has encountered. Especially characteristic of modern education is the study of individual differences in mental constitution, and the attempt to recognize

these differences in classification, discipline and teaching. The traditional classification on the basis of physical age has given way to the recognition of mental level and the possibility of its determination in education long before it will disappear from law and social custom.

Modern psychological experiments and investigations must be taken into account in any effort to adjust the educational program to such differences as may be due to race and ancestry. The provision of equal and identical educational and professional opportunity and encouragement now rapidly being extended to all individuals regardless of sex is in part due to, and throughout justified by, the demonstrations of experimental science that in no measurable respect, whether in type, degree, or variability, is mental capacity originally conditioned by the biological accident of sex.

In the modern school not only are efforts made to adjust the curriculum and the extra academic activities to the individual differences of the pupils, but special classes and methods are adapted to the particular needs of the feeble-minded, the backward, the precocious, the normal, the sick, the crippled, the blind and the deaf. Even special classes for those to whom spelling or arithmetic present special difficulties are by no means uncommon. The poor speller, the truant, the blockhead, the prodigy, instead of being sources of worry, prayer and administra-

tive despair, are fast becoming the subject-matter of zealous and scientific research.

In the study of the original equipment of the race, of the ways in which individuals differ, of the processes of learning and retention, of the special mental processes involved in mastering the school subjects, and in the organization of the school program, the work of the day, the method of the classroom, and the arrangement of the curriculum, in these and in many other ways the content of psychology is of indispensable service in education.

Psychological Technique and Education.—The various applications of psychological procedure, apparatus and methods range from the use of classical psychological experiments in the demonstration of the laws of learning, practice, fatigue, etc., to the derivation and employment of scales for the measurement of school products. They include, between these limits of academic and practical extremes, such further applications as are involved in the employment of psychological experiment for the solution of educational problems, and the use of scales of mental measurement for educational classification and guidance. These various forms of application may best be presented in the form of concrete examples.

A familiar experiment of the psychological laboratory consists in the observation and recording of the processes gone through in acquiring some new habit or act of skill. An animal may be placed in

a cage from which it can escape only by performing some simple or complex set of movements, after which it may be rewarded by food. Or a human being is given some new task to learn, such as solving a puzzle, acquiring dexterity in some muscular feat, or becoming proficient in the use of some instrument, some set of symbols, some type of judgment. Records of the modes of attack, variations in method, types of errors, rate of learning, conditions of improvement, degree and ease of retention, tendency to distraction and interference, effects of disturbance, introspections of the worker, and similar facts, enable the experimenter not only to picture in a graphic way the course of the act of learning, but also to formulate various general principles concerning the relative effectiveness of different methods and the differences between individuals.

The work of the teacher consists mainly in supervising the formation of habits of these and related types. It is therefore found useful for the teacher to become familiar, through performing such experiments in the laboratory or observing them in the demonstration, with the tendencies and principles underlying the learning process. In a similar way the classical experiments in memory, perception, attention, etc., all have their technical and professional value in picturing in concrete and systematic form the psychology of the pupil. It would be difficult to find a classical psychological experi-

ment that does not, at some point or other, admit of practical application in education.

If now, for the more or less artificial materials and acts of the laboratory, the mastering of actual school subjects and operations be substituted, the laboratory technique leads to a genuine experiment in education, especially if the experiment be performed on such individuals as comprise the school population. In this way the value of various methods of instruction, arrangements of material, amounts of drill, distributions of practice, proportions of study, rest and recitation, lengths of class period, etc., may be accurately and quantitatively determined. In such cases the laboratory technique is employed not merely by way of illustration, but as an instrument of educational research.

By way of illustration the oft-quoted studies of Rice, Stone, Chapman, Courtis, Kirby, White and others may be cited. By such experimental methods, for example, one investigator was able to measure the arithmetical abilities of pupils in several grades in a number of schools. He found that the results varied greatly from school to school, the capacity in each school appearing consistently in all of its grades. By comparing these data with the amount of time given to arithmetic in the school programs, the size of the classes, the age of the pupils, and the conditions of their home life, it was shown that none of these factors was responsible for the differences in arithmetical ability. It is hence suggested that

variations in methods of teaching and supervision are perhaps the responsible factors. The influence of these factors may be measured in the same experimental way.

By a somewhat similar procedure Kirby was able to show that in the case of practice in arithmetic under ordinary school conditions, "the greatest gains were made by the groups which had their practice in the shortest periods." Thirty-nine classes, comprising in all 1,350 school children, served as subjects of these experiments, practicing in addition and division. In the case of addition all classes practiced for the same total time, 75 minutes. But this total time was divided and distributed in different ways with different groups. In all cases there was an initial and a final period, of 15 minutes each. The intervening 45 minutes of practice were distributed in four different ways, over different periods of time. One group had two periods of 22.5 minutes, another, three periods of 15 minutes, another, seven 6-minute periods and one 3-minute period, and the fourth 21 2-minute periods and one 3-minute period. In these groups, then, the intervening practice periods are of different length but amount to the same total time. In the case of division three groups practiced for 60 minutes. In all cases there was an initial and a final period of 10 minutes, the intervening periods being broken up into smaller periods of 20 minutes, 10

minutes and 2 minutes in the three groups, respectively.

The results of these experiments were as follows: In addition the gains from practice in 22.5 minute, 15 minute, 6 minute and 2 minute periods, respectively, were in the relation 100, 121, 101 and 146.5. In division, the gains from practice in 20 minute, 10 minute and 2 minute periods, respectively, were in the relation 100, 110.5 and 177. These experiments were made from the practical point of view, from which it is immaterial how much the children study the matter that is being practiced outside of school hours. If we assume that they did so as much when the practice periods were distributed in many short periods as when they were distributed in few long periods, the results show that the shorter practice periods, especially the 2 minute periods, are much more advantageous.

The derivation of scales for the measurement of intellectual level was originally prompted by the urgent need for such measures in school supervision and administration. In the comparative experiments of pedagogy it is desirable, if possible, to select the pupils to be tested in such a way that groups of equal native capacity be submitted to the conditions of the experiment. In the consideration of an individual pupil and his educational difficulties it is first of all important to know whether he brings a normal intelligence to bear on these difficulties or whether he is originally inferior or superior in mental equipment. His disposition and treatment, his classification and direction must be random unless

these facts be ascertainable. Scales of mental measurement make possible the prediction, long beforehand, of the most probable quality of the pupil's later academic and vocational achievement, thus in many instances saving waste to society, accident to industry, expense and worry to parents, and fruitless effort to teachers and supervisors. The individualization of pedagogy is made more completely possible by the construction and elaboration, by psychological investigators, of the various types of scales for mental measurement and intellectual diagnosis. Through the intelligent use of these products of the laboratory the selective work which the test of the school curriculum has traditionally required years to accomplish may often be effected in a single hour.

Growing out of the development of scales for the measurement of general mental level and closely related to this movement in method and purpose, is the recent work on the derivation of scales for the measurement of special school products. By methods originally devised for the measurement of experiences and materials whose values could be serially arranged but not quantitatively expressed, the qualities of such products as handwriting, literary composition, drawing, spelling, arithmetic, reading, language ability, mechanical construction, etc., can now be compared. Such comparison enables the formulation of scales for the measurement of these school products, which may be used to advantage in the elementary subjects, in the place of the traditional

"examination" with its manifest unreliabilities in type of question, relative difficulty of answer and solution, assignment of grades, and standards of achievement.

By the use of such scales the pupil himself is enabled to observe in a definite way the progress of his learning. The teacher is enabled to check up her methods of instruction and drill, since such scales make possible direct comparison of one class with another. The supervisor may from time to time determine in exact ways the relative effectiveness of the instruction of different teachers, so far as the value of this instruction depends on the character of the children's work. Standards of performance may be laid down for the various school grades and uniformity of practice and demand developed in different parts of the school system. Statements of individual capacity in school subjects may assume quantitative form, and the assignment of grades and marks loses much of its variability and unreliability. The work of one school system may be compared with another, and the work of surveys thus extended beyond the consideration of buildings and grounds, ventilation and salaries, so as to include the actual psychological products of the classroom.

Among the product scales that have been devised for such educational purposes the following are especially well known: Woody Arithmetic Scale, Courtis Arithmetic Tests, Thorndike Handwriting,

Reading and Drawing Scales, Hillegas and Harvard-Newton Composition Scales, Ayres Penmanship and Spelling Scales, Trabue Language Scales, and Kelly Reading Scale. The student of applied psychology should be interested in becoming acquainted with one or more of these instruments, with the technique of their formulation and application and the nature of their results. Such scales are now being widely employed in the classroom, in educational research and in school surveys, and constitute perhaps the most material contribution of psychological technique to education.

CHAPTER XVIII

THE FUTURE OF APPLIED PSYCHOLOGY

Objections have sometimes been made to the use of the term "applied psychology," on the ground that the work commonly designated by that term is not in the strict sense psychological,—not calculated to enlarge the boundaries of psychology as a science. It has been suggested, for example, that some such terms as "human engineering" or "psychotechnics" would more properly apply. Whatever may be the cogency of such objections, the term has come to have a definite meaning in its present form, and one which in no way conflicts with any other usage of these words. Applied psychology, both as a term and as a technical type of interest and pursuit, has apparently come to stay. More important than a dispute over its name is the problem of setting it well and legitimately upon its way, guarding it from extravagant claim and charlatanry, and establishing it upon a foundation of valid and trustworthy data and methods.

In the application of any science to the concrete purposes of practical life some adjustment of existing machinery or the development of some appropriate institution or professional avenue must al-

ways be made. The practical worker, whether judge, employer, teacher, physician, salesman, executive or reformer cannot at the same time devote himself entirely to his practical work and also master a science. Nor can the scientist at once and indiscriminately carry over his knowledge or his methods to the solution of practical problems without giving heed to the manifold conditions and circumstances in which those problems occur. In ordinary circumstances he cannot even become clearly aware of the nature of the problems. Some method is always necessary whereby the science may be made available to the practical worker, and the scientific worker informed of the nature and particular circumstances of the practical problems.

In the case of the different sciences which have made practical contribution in modern life various methods of meeting this demand have arisen. Thus in the case of chemistry the method has been established of placing the scientifically equipped worker in the midst of the industrial plant, providing him with adequate means of research and definitely setting for him the nature of the problem with which his research is to deal. The chemist makes little pretense of mastering the details of industry, and the manufacturer does not pretend to understand the technique nor even the vocabulary of the chemist. Each is a specialist in his own field and each accepts the problems or results of the other with full co-operation.

In the case of physics a rather different solution has been found. In place of the industrial laboratory of physical research there has developed an entirely new professional group, the engineers, who may neither profess to further physical research nor to occupy themselves with the business details of contracting, supplying or manufacture. For their training there have developed special and highly technical forms of instruction and practice, in which the known principles and technique of the physical laboratory are demonstrated in the construction and planning of buildings, machinery, roads, bridges, canals, vehicles, etc. The lines of division are of course not rigidly drawn, and an engineer may by his technical advances afford new problems or new knowledge of a scientific kind or he may identify himself more closely with the business enterprises within his field.

In the case of psychology neither of these two methods of adjustment has yet been widely adopted, although tendencies in both directions may be observed. In general three other types of adjustment or reaction seem to have been attempted, with by no means completely satisfactory results in any case.

In educational organization, supervision and teaching the method generally followed has been that of giving the practical worker, the superintendent or teacher, such psychological knowledge and training as can be incidentally inserted into the course of study in the training school. Thus mea-

gerly equipped the practical worker has attempted to apply this knowledge or technique, in the form of principles, methods of measurement, etc., in concrete class work, discipline, formulation of a curriculum, selection of methods of instruction, etc. This is much the same method that would be followed by the manufacturer who had taken courses in chemistry during his college career and then tried in his occasional hours of leisure or moments of emergency to conduct the chemical investigations for his establishment. Only in very recent years have cases occurred in which the psychological expert as such is called into the school system, for the conduct of special types of survey, diagnosis, or research, in much the same way that the chemist is placed in a modern manufacturing industry.

In the case of business a rather different method has been followed. Here the practical worker has been very slow to appropriate such psychological knowledge and technique as may have been available. Instead, the psychologist, occupied mainly with the work of teaching and research, has been compelled to acquaint himself in a more or less amateurish way with the problems of business, marketing and management, working in many cases in the face of discouragement or half-hearted coöperation. In education the practical worker laid claim to psychological knowledge; in business the psychologist was compelled to pretend or to acquire familiarity with commerce and manufacture. In fact only

within the last ten years have there been evidences of enthusiastic coöperation, support and consultation on the part of the most enterprising executives, manufacturers and agencies.

The third unsatisfactory form of reaction is to be found in that border line of psychology and medicine known as psychopathology or clinical psychology. In the determination of mental status, condition and responsibility, in the diagnosis of mental defect, in the grading and classification of retarded school children, in the acceptance of applicants to charitable institutions, the admission of immigrants and the disposal of various cases that come before the courts or in the reformatories or prisons, there has not been so much an adjustment, but rather an undesirable sort of rivalry and professional jealousy between the psychologists and the doctors. Old-fashioned physicians, lacking the modern psychiatric and psychological knowledge and technique have contended for the field of work with academically trained and clinically ignorant psychologists. The ideal worker in this field, the psychopathologist, with complete psychological and neurological training and practical medical knowledge has consequently been much retarded in development.

Of all these five modes of adjustment the three that have been most characteristic of psychology in the past would seem to be the most undesirable as final solutions, from all points of view. Rivalry and professional jealousy mean waste and inefficiency. The

investigator and teacher in general psychology or even in its special fields cannot, except under very exceptional circumstances, well do justice to his science while also endeavoring to acquire a business vocabulary and an expert familiarity with commerce, industry and management. For the practical worker in these fields to acquire in an incidental way the requisite expert knowledge of psychology is equally hopeless. For the development of the "psychotechnic engineer," types of instruction, practice, and experience are necessary which under the present organization of our university departments cannot easily be provided.

It would seem then that the solution of the immediate future in applied psychology will be similar to that commonly adopted in the case of the applied chemists, bacteriologists, etc. It is to be expected, however, that in time the rapid development now going on in applied psychology will make necessary the engineering type of psychotechnic expert, the consulting psychologist.

APPENDIX

SUPPLEMENTARY READINGS

The following list of selected references is given as a guide to further reading and as a supplement to the book when used as a class text. It is of course very far from being a complete bibliography of Applied Psychology, for a complete list would now include many hundreds of references. The list limits itself in the main to books and articles in English, and to sources which are readily accessible in almost any college and university library. In many of these references will be found more complete bibliographies relating to the special topics therein discussed. The references given will, however, serve to introduce the reader and student to the numerous and wide fields of practical application which are necessarily presented in the textbook in very abbreviated fashion.

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